

Overview

MacBook Pro (15-inch, 2018)



What's New

- **Processor:** 2.2GHz or 2.6GHz 6-core Intel Core i7 processor, configurable to 2.9GHz 6-core Intel Core i9 processor
- **Retina Display:** 15.4-inch (diagonal) with True Tone
- **Graphics Cards:** Radeon Pro 555X, Radeon Pro 560X, Radeon Pro Vega 16, Radeon Pro Vega 20
- **Storage:** 256GB, 512GB, 1TB, 2TB, or 4TB onboard flash storage
- **Memory:** 16GB or 32GB of 2400MHz DDR4 onboard, not user installable
- **Camera:** integrated camera and ambient light sensor
- **Apple T2 Security Chip:**
 - Secure Enclave
 - Secure boot
 - Encrypted storage
- **Diagnostics:**
 - Apple Service Toolkit version 2 (AST 2)
 - The [Trackpad Calibration Check](#) must be performed after every repair.
 - The System Configuration **must** be performed after a top case, logic board, Touch ID board, or display assembly repair. Refer to [TP1657: System Configuration for Macs with the Apple T2 Security Chip](#) for more information.

For product configurations, refer to Tech Specs at support.apple.com/specs/#macbookpro.

Important Service Considerations

This computer model's design requires special service considerations:

- **Important:** Only Apple-certified technicians should repair this computer. For more information, refer to [OP1859: About Apple service certifications](#).
- **System Configuration:** When replacing a top case, logic board, Touch ID board, or display assembly, the repair is not complete until the System Configuration has been performed. Refer to [TP1657: System Configuration for Macs with the Apple T2 Security Chip](#).
- **Graphics Configuration:** Before ordering a replacement part for logic board, bottom case, or heat sink, refer to [TP1721: Repair Requirements based on Graphics Configuration](#) to find the correct part number.
- **Startup and Power:** There is no startup sound. The following actions automatically turn on the computer:
 - Lifting the lid
 - Connecting your Mac to a power adapter while the lid is open
 - Connecting your Mac to a power adapter while the lid is closed and it's connected to an external display
 - Pressing any key
 - Pressing the trackpad
- **Battery Safety:** Before beginning any repair, install the battery cover, disconnect the battery cable from the logic board, and remove the BMU screw.
- **Battery Service:** The battery is not a replaceable part. Never remove the battery from the top case. To replace a battery, you must replace the top case.
- **Bottom Case:** The bottom case must be serviced with the bottom case removal/install fixture kit (076-00290)
- **Logic Board and Touch ID Board:** The logic board and Touch ID board are paired. When the logic board is replaced, the Touch ID board must also be replaced. **However**, the logic board does not need to be replaced when only the Touch ID board is replaced.
- **Touch ID Board:** The Touch ID board requires a special tool for reassembly: Touch ID alignment tool (923-01586).
- **Top Case:**
 - The top case comes with the battery, keyboard, trackpad, microphone, speakers, IPD flex cable, BMU, and keyboard flex cable. Returned top cases must be packaged according to strict guidelines. If the battery, keyboard, microphone, or trackpad must be replaced, you must replace the top case. The keyboard flex cable is a separate, replaceable part. Refer to [TP1538: Battery Handling and Storage](#). Repairs must be done in a designated area for lithium polymer battery repairs.
 - Regional top cases have the same base part number, but they include a language code prefix (for example, Italian = T661-10345). Be sure to choose the correct keyboard language when ordering a top case. To help determine the correct country code and keyboard language, refer to [HT201794: How to identify keyboard localizations](#).
- **Trackpad Calibration Check:** The calibration of the Force Touch trackpad must be verified after every repair. For more information refer to [TP1314: Trackpad Calibration Check](#).
- **Thermal Ducts:** The fan ducts are rubber gaskets that sit on top of the fans. They are fragile and held down with adhesive. Use care when lifting them to access the fans.

Starter Kits

The following kits are needed to service this computer:

- Battery Safety Kit, refer to article [OP685: Embedded battery workstation setup for Apple notebook computers and iPhone](#)
- Battery Cover, 923-02532, package of two
- Bottom case removal/install fixture kit, 076-00290
- Touch ID alignment kit, 923-01586

Use Software Update

MacBook Pro (15-inch, 2018) ships with a model-specific version of macOS. Refer to [HT201686: Use the Mac operating system that came with your Mac, or a compatible newer version](#) to make sure the system build is correct for this computer model. Using Software Update, check for and apply the latest software and firmware updates.

Overview

MacBook Pro (15-inch, 2019)



What's New

- **Processor:** 2.6GHz 6-core Intel Core i7 or 2.3GHz 8-core Intel Core i9 processor, configurable to 2.4GHz 8-core Intel Core i9 processor
- **Retina Display:** 15.4-inch (diagonal) with True Tone
- **Graphics Cards:** Radeon Pro 555X, Radeon Pro 560X, Radeon Pro Vega 16, Radeon Pro Vega 20
- **Storage:** 256GB, 512GB, 1TB, 2TB, or 4TB onboard flash storage
- **Memory:** 16GB or 32GB of 2400MHz DDR4 onboard, not user installable
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 - Regional top cases have the same base part number, but they include a language code prefix (for example, Italian = T661-13163). Be sure to choose the correct keyboard language when ordering a top case. To help determine the correct country code and keyboard language, refer to [HT201794: How to identify keyboard localizations](#).
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- Touch ID alignment kit, 923-01586

Use Software Update

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Serial Number Locations

The system serial number and model number are located on the bottom case. Turn over the computer to view the numbers etched on the bottom case near the hinge.

Note: Bar code readers can be used to read serial numbers inside the computer. For information on the serial number format, refer to [OP51: Frequently Asked Questions and Answers Concerning Apple's New Serial Number Format](#).

Model and EMC Numbers

Models	Model Number	EMC Number
2016		
MacBook Pro (13-inch, 2016, Two Thunderbolt 3 Ports)	A1708	2978
MacBook Pro (13-inch, 2016, Four Thunderbolt 3 Ports)	A1706	307
MacBook Pro (15-inch, 2016)	A1707	3072
2017		
MacBook Pro (13-inch, 2017, Two Thunderbolt 3 Ports)	A1708	3164
MacBook Pro (13-inch, 2017, Four Thunderbolt 3 Ports)	A1706	3163
MacBook Pro (15-inch, 2017)	A1707	3162
2018		
MacBook Pro (13-inch, 2018, Four Thunderbolt 3 Ports)	A1989	3214
MacBook Pro (15-inch, 2018)	A1990	3215
2019		
MacBook Pro (13-inch, 2019, Two Thunderbolt 3 Ports)	A2159	3301
MacBook Pro (13-inch, 2019, Four Thunderbolt 3 Ports)	A1989	3358
MacBook Pro (15-inch, 2019)	A1990	3359



Transferring the System Serial Number

When replacing a bottom case, retain the user's original bottom case until the repair is complete. Before installing a replacement bottom case, use a fine-tip permanent marker to write the original system serial number inside the bottom case.



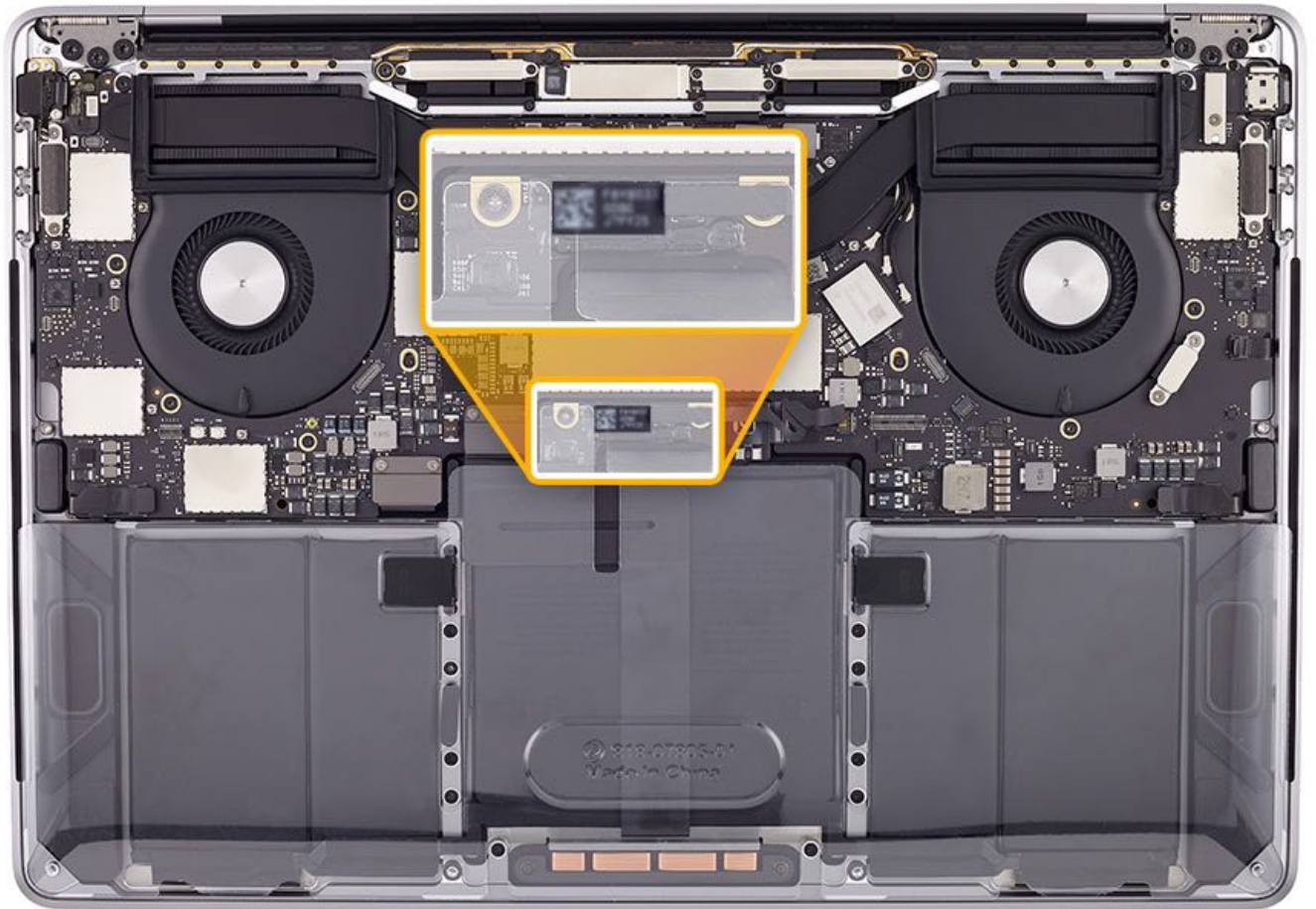
Battery Serial Number

Copy the original battery serial number when reporting a top case return to Apple. Do not copy the replacement serial number.

An example of a MacBook Pro (13-inch, 2016 and 2017) and MacBook Pro (13-inch, 2019, Two Thunderbolt 3 Ports) battery serial number, located underneath the trackpad flex cable, is shown below. Carefully peel back the trackpad flex cable to view the battery serial number.



An example of a MacBook Pro (13-inch, 2018 and 2019, Four Thunderbolt 3 Ports) battery serial number, located on the BMU board, is shown below.



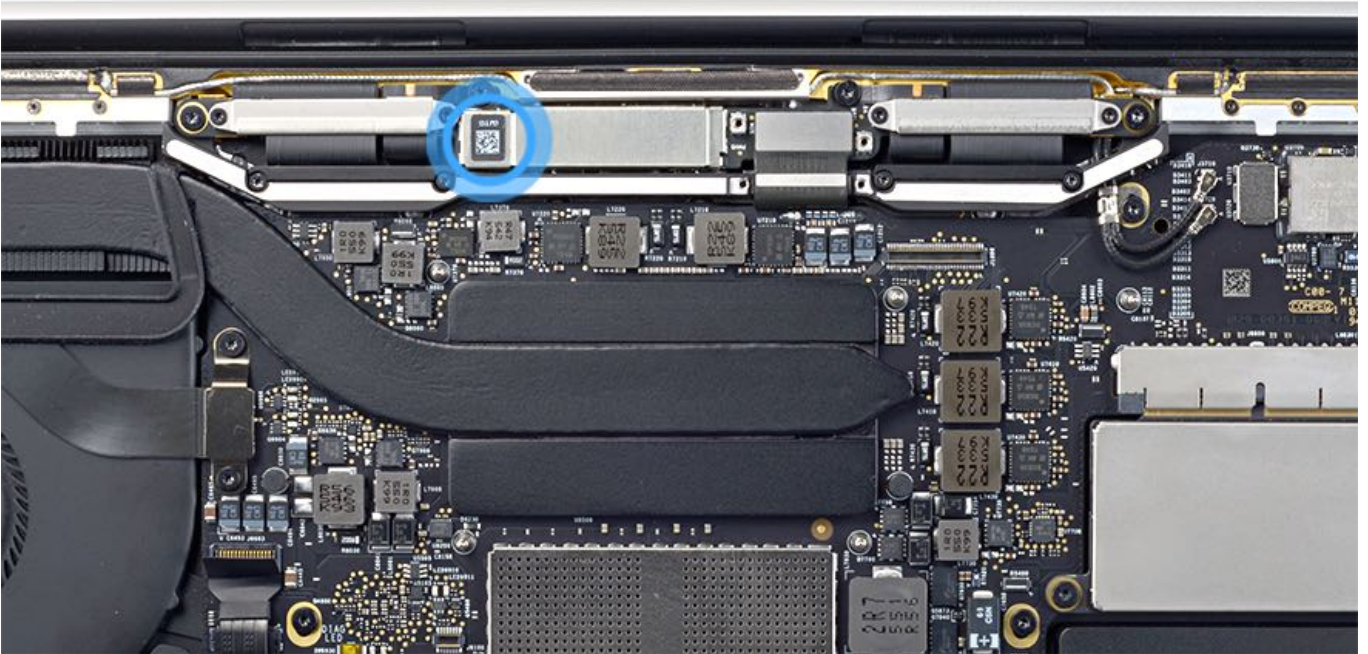
An example of a MacBook Pro (15-inch, 2016, 2017, 2018, 2019) battery serial number, located on the BMU board, is shown below.



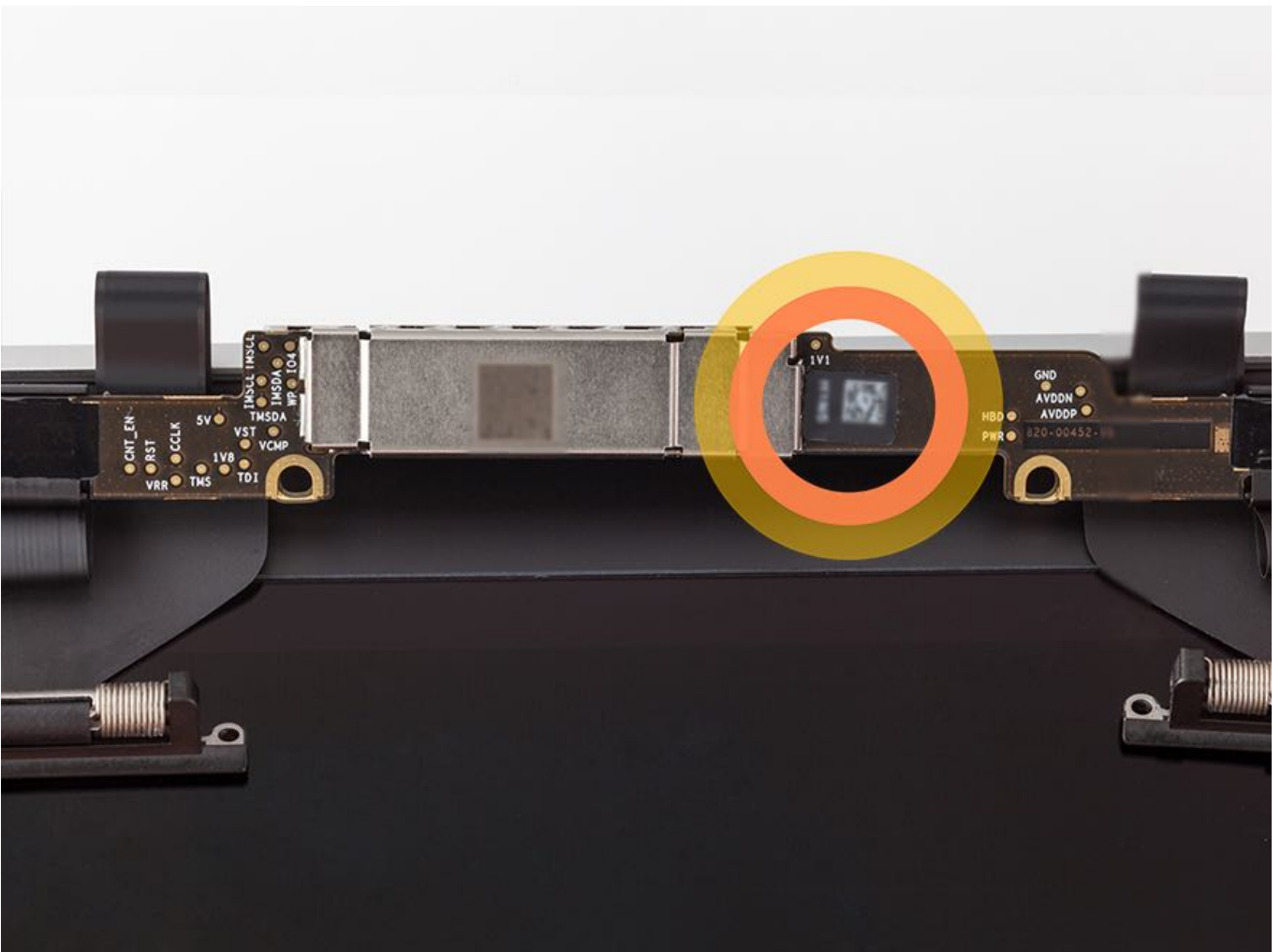
Display Assembly Serial Number

The display assembly serial number is located on the TCON board.

An example of a MacBook Pro (13-inch, 2016, 2017, 2018, 2019) display assembly serial number is shown below.



An example of a MacBook Pro (15-inch, 2016, 2017, 2018, 2019) display assembly serial number is shown below.



Auto Boot

Auto Boot for MacBook Pro (2016 and later), MacBook (Retina, 12-inch, 2017 and later), and MacBook Air (Retina, 13-inch, 2018 and later)

There are certain features of these Mac models that [automatically turn on the computer](#). If the computer turns on during a repair, then it may become damaged.

The previous strategy for handling Auto Boot was to disable it in Terminal prior to a repair, and reenable it after the repair. This has been discontinued in favor of the following model-specific strategy:

MacBook Pro

- Ensure the battery cover is installed.
- Disconnect the battery flex cable and remove the BMU screw.

MacBook and MacBook Air

- Ensure the battery cover is installed.
- Press the battery disconnect button with a black stick to disengage power to the logic board.

Performing these steps will prevent the computer from automatically turning on during repair. Refer to the Service Guide for the model being repaired for additional information.

Data Migration

Data Migration on MacBook Pro with Thunderbolt 3 ports

Use Migration Assistant in target disk mode to transfer data between a functioning MacBook Pro with Thunderbolt 3 ports and another Mac computer.

To transfer data between a MacBook Pro with Thunderbolt 3 ports and another Mac computer with Thunderbolt, connect a Thunderbolt 3 (USB-C) to Thunderbolt 2 Adapter to the MacBook Pro and use a Thunderbolt cable to connect the adapter to the other Mac computer. Then follow the steps for using Migration Assistant in target disk mode to move your files. For older models with FireWire ports, use the Apple Thunderbolt to FireWire Adapter with a FireWire cable, then follow the steps for using Migration Assistant in target disk mode.

For more information on how to move content to a new Mac computer using Migration Assistant in target disk mode, refer to [HT204350: How to move your content to a new Mac](#).

Tools:

- Belkin Thunderbolt 3 Cable (923-01131) or Thunderbolt 3 (USB-C) Cable (661-09458)



- Apple Thunderbolt Cable (661-6029)



- Thunderbolt 3 (USB-C) to Thunderbolt 2 Adapter (661-06668)



- Apple Thunderbolt to FireWire Adapter (661-6585)



For further reference, refer to the following articles:

- [HT201853: About Apple video adapters and cables](#)
- [HT207266: About the Apple Thunderbolt 3 \(USB-C\) to Thunderbolt 2 Adapter](#)
- [HT204360: Adapters for the Thunderbolt 3 \(USB-C\) or USB-C port on your Mac or iPad Pro](#)
- [HT201163: Using USB devices with your Mac](#)

Data Transfer for Macs with the Apple T2 Security Chip

Desktops and notebooks that have the Apple T2 Security Chip include security features that require a specific process for transferring data. Data from a damaged logic board can sometimes be captured and transferred before any service.

Important:

- If a logic board or flash storage needs to be replaced, data recovery must be attempted before System Configuration is performed. After System Configuration has been performed, data recovery is no longer available.
- This process will leave the customer system in a recovery state that makes the system appear unresponsive.
Note: Completing the repair and running System Configuration will resolve this. If a repair has not been performed, perform a restore using Apple Configurator 2. For more information on Apple Configurator 2, refer to [Restore Apple desktop computers that have the Apple T2 Security Chip](#) and [Restore Apple portable computers that have the Apple T2 Security Chip](#).
- Files and folders cannot be modified or deleted from the customer computer volumes. Those volumes are intended to be read only.
- After the transfer process, some files such as .bin, .etc, .tmp, and .usr may be visible on the external hard drive. This is expected behavior. Do not delete or modify these files or folders as doing so may cause issues for the customer when they migrate information from the external hard drive back to the customer's computer.
- It can take 10–20 minutes for the external hard drive to be partitioned.
- Data is transferred at USB 2.0 speed. The length of time required to complete this process depends on how much data is on the drive. This process could take up to four days.
- When transfer is complete, return the hard drive with the customer's data to the customer. Explain how they can migrate their data back to their computer using migration assistant.

For video instruction, refer to [SV373: Macs with the Apple T2 Security Chip: Data Transfer to an External Hard Drive](#).

Tools:

- Power cord
- USB-C to USB-C Charge Cable included with portables (661-06670) or USB-A to USB-C Apple TV Restore Cable (923-00504)



- A host computer with:
 - macOS Mojave 10.14.5 or later.
 - Mac Configuration Utility (MCU) installed. For information on how to set up the host computer, refer to [OP476: Latest Apple Service Toolkit download links and documentation](#).
 - Internet connection
- An external hard drive of equal or greater capacity than the installed system storage.
Note: The hard drive will be configured and password protected with the customer's computer serial number during the process.

Steps:

1. Verify that part 076-00399 Data Transfer Setup (Retail) or 076-00410 Data Transfer Setup - Transaction Only (ASP) has been added to the repair and saved.
2. Launch the [Diagnostic Console](#) and start an AST 2 diagnostic session using the customer computer serial number.
3. Connect the customer's computer to the host computer. If the host computer does not have a USB-C port, use a USB-C

to USB-A cable. It is important to connect the USB-C cable to the correct port or the process will not run.

- For notebooks: Use only the USB-C port closest to the caps lock key.



- For iMac Pro: Use only the USB-C port closest to the Ethernet port.



- For Mac mini (2018): Use only the USB-C port closest to the HDMI port.



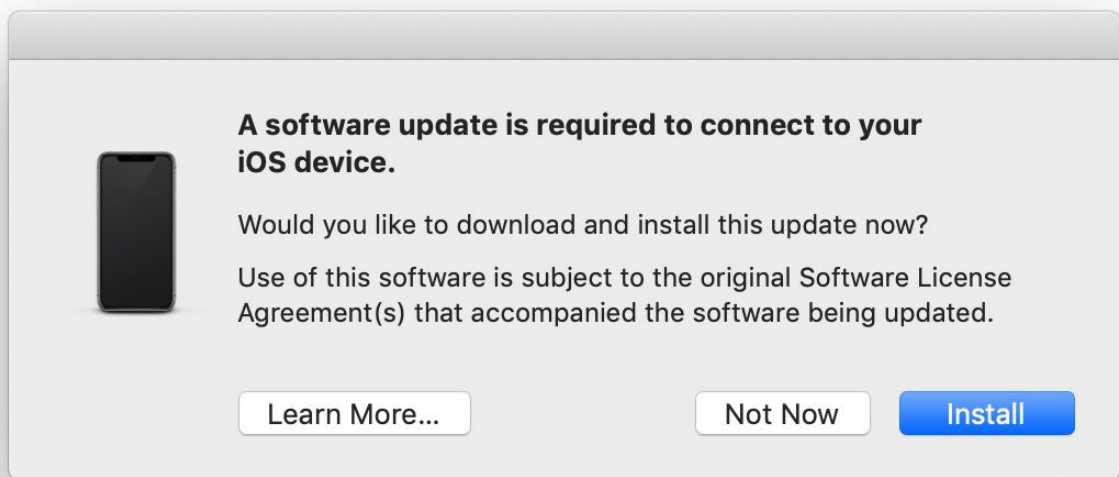
4. Verify that the host computer is turned on, connected to power, and connected to the Internet.

5. Start up the customer's computer in DFU mode. Refer to [TP1758: Device Firmware Update \(DFU\) mode for Computers with the Apple T2 Security Chip](#).

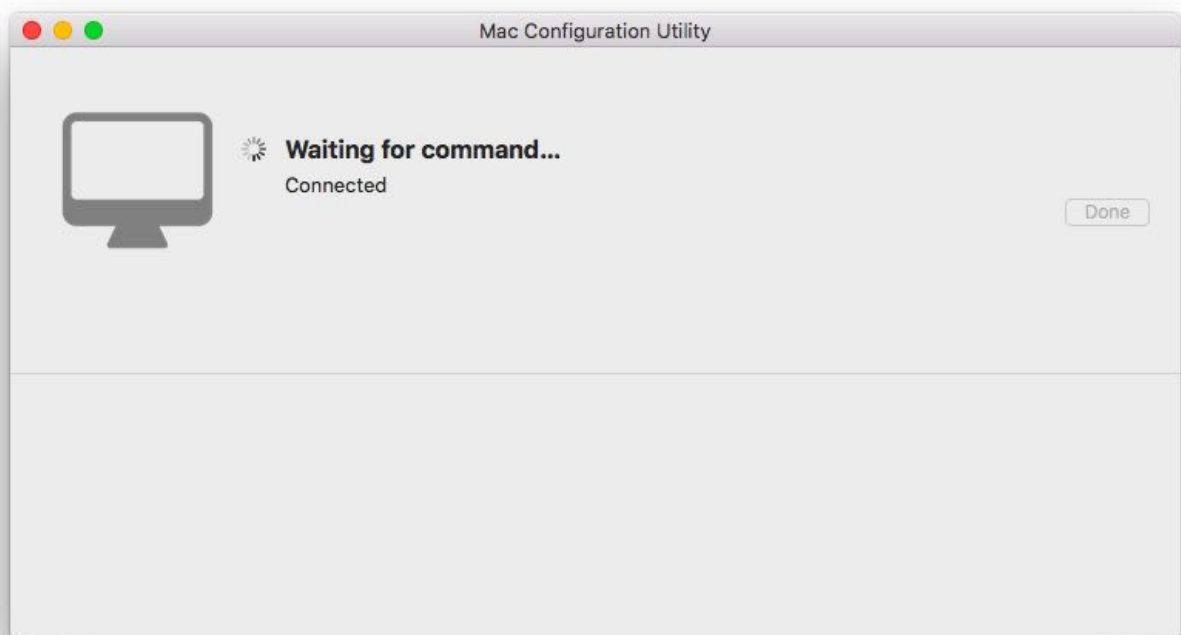
- For desktops: Press and hold the power button on the rear enclosure and connect the power cord. Continue to hold the power button until you see the prompt appear in Mac Configuration Utility, which may take up to 10 seconds. For video instruction, refer to [SV402: Desktop Computers with the Apple T2 Security Chip: DFU Mode](#).
- For notebooks: Press and hold the power button, then press and hold Left Control-Left Option-Right Shift until you see the prompt appear in Mac Configuration Utility, which may take up to 10 seconds. For video instruction, refer to [SV401: Notebook Computers with the Apple T2 Security Chip: DFU Mode](#).



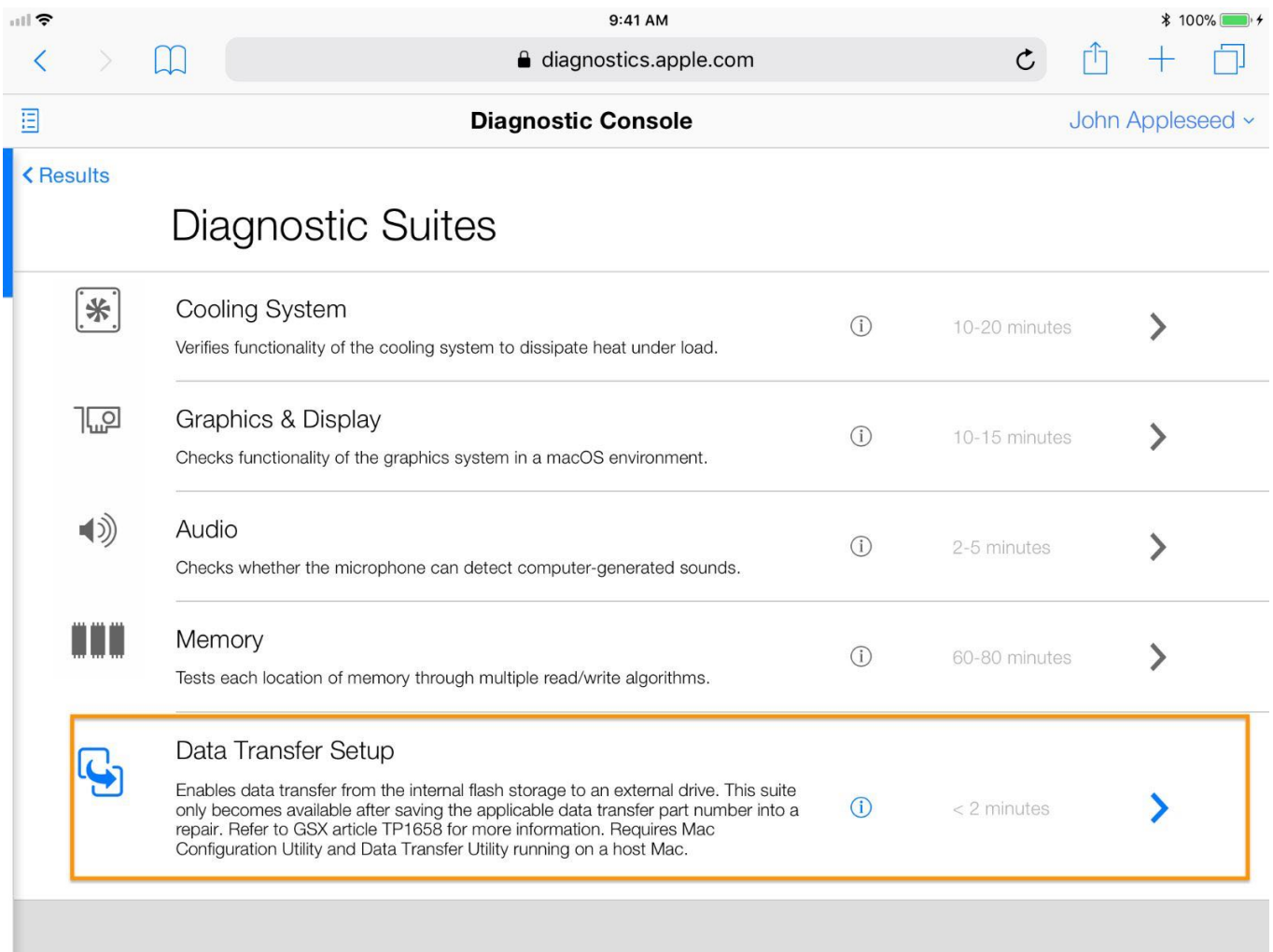
Note: An alert message may appear prompting a software update. Choose “Install.” After the installation is complete, continue to the next step in the System Configuration process.



6. MCU will automatically launch and a dialog box will appear on the host computer screen.



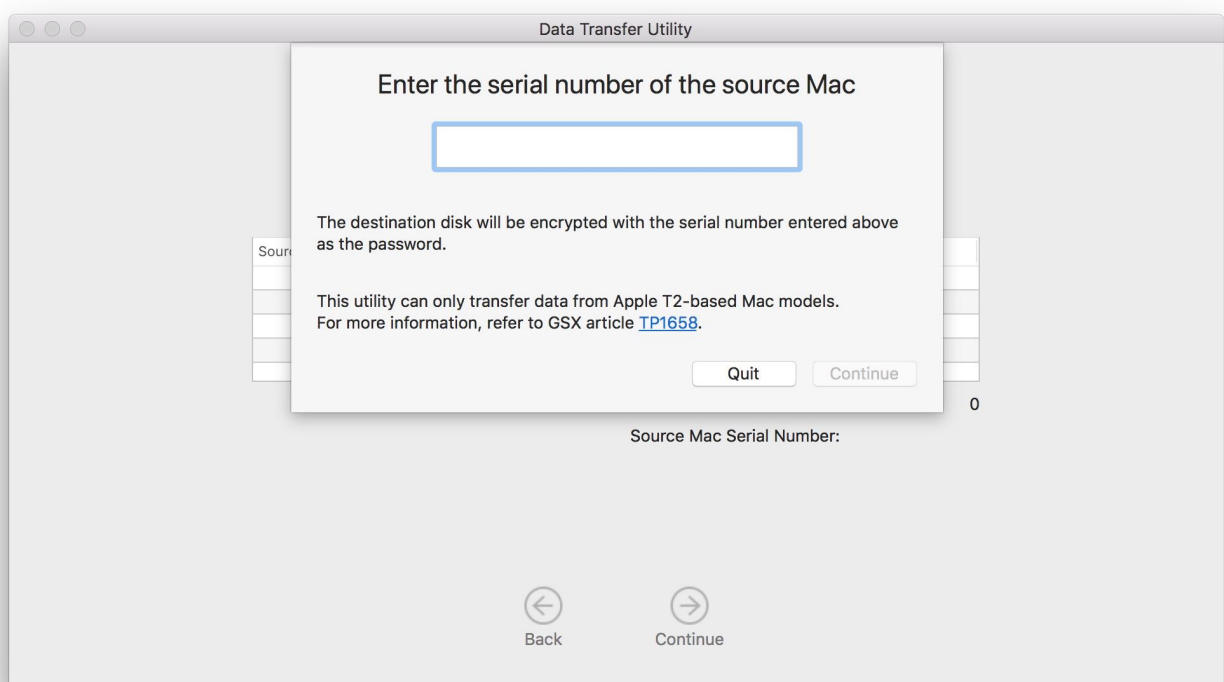
7. From the list of diagnostic suites in the Diagnostic Console, select Data Transfer Setup.



Note:

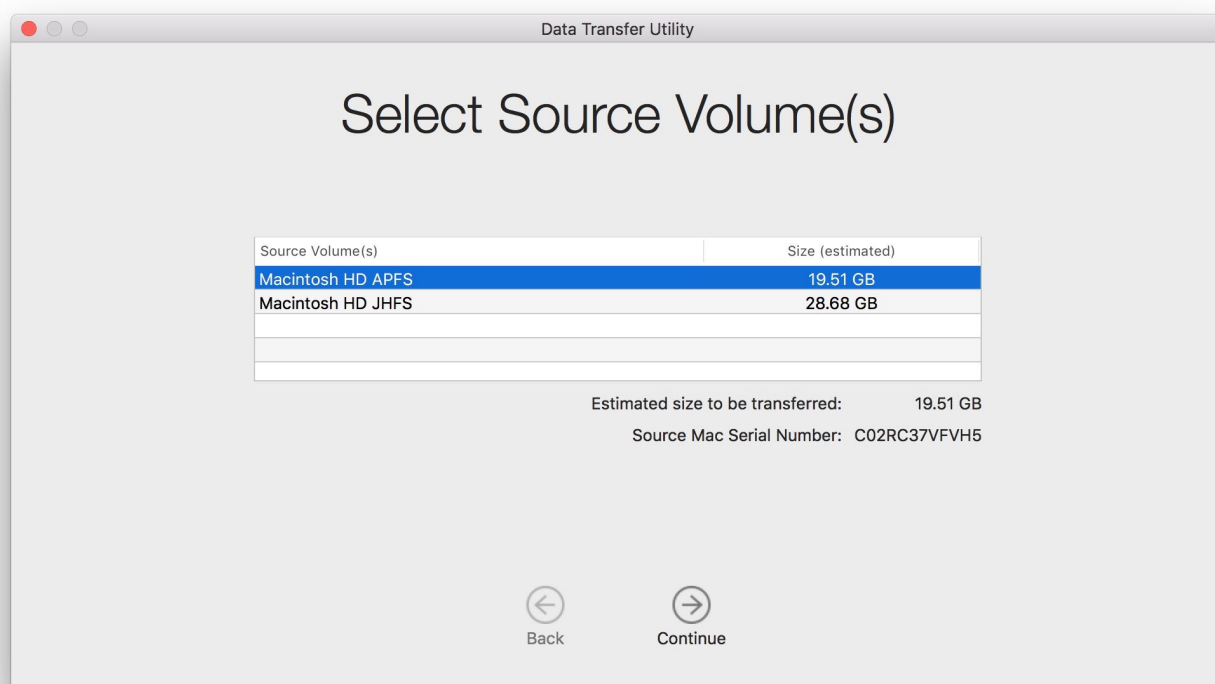
- If the customer has FileVault enabled, you will be prompted to enter the password.
- The customer's computer will not display anything on the screen to indicate status. The only observable indication will be when the drive mounts as an external volume on the host Mac running MCU.

8. Open the Data Transfer Utility app on the host machine and enter the serial number of the customer's computer.

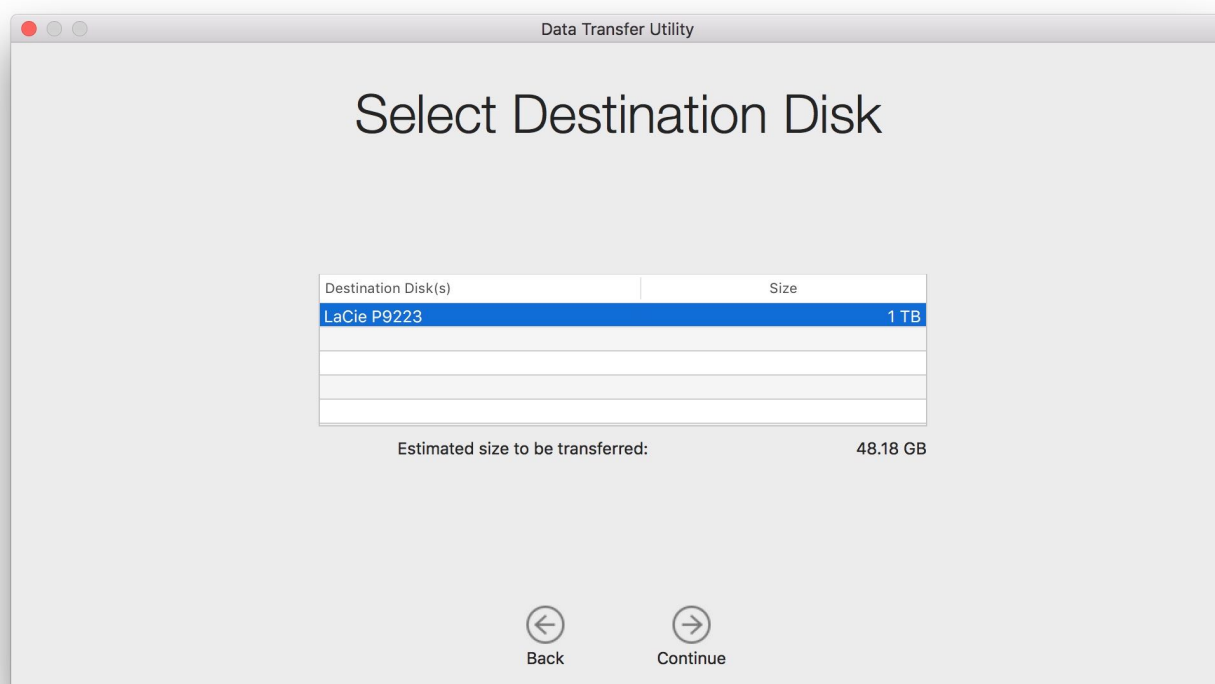


9. Select the source volume(s) and click Continue.

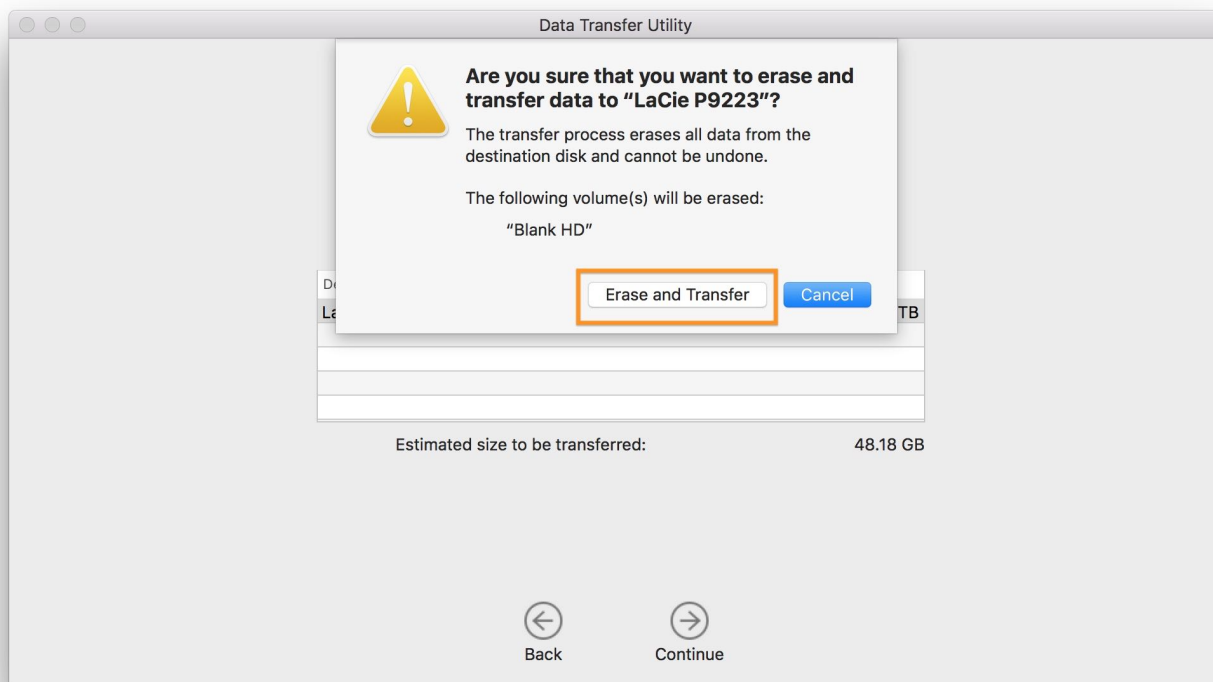
Note: If more than one source volume is available, multiple volumes can be selected to be transferred.



10. Connect an external hard drive to the host machine. Select the destination, and click Continue.

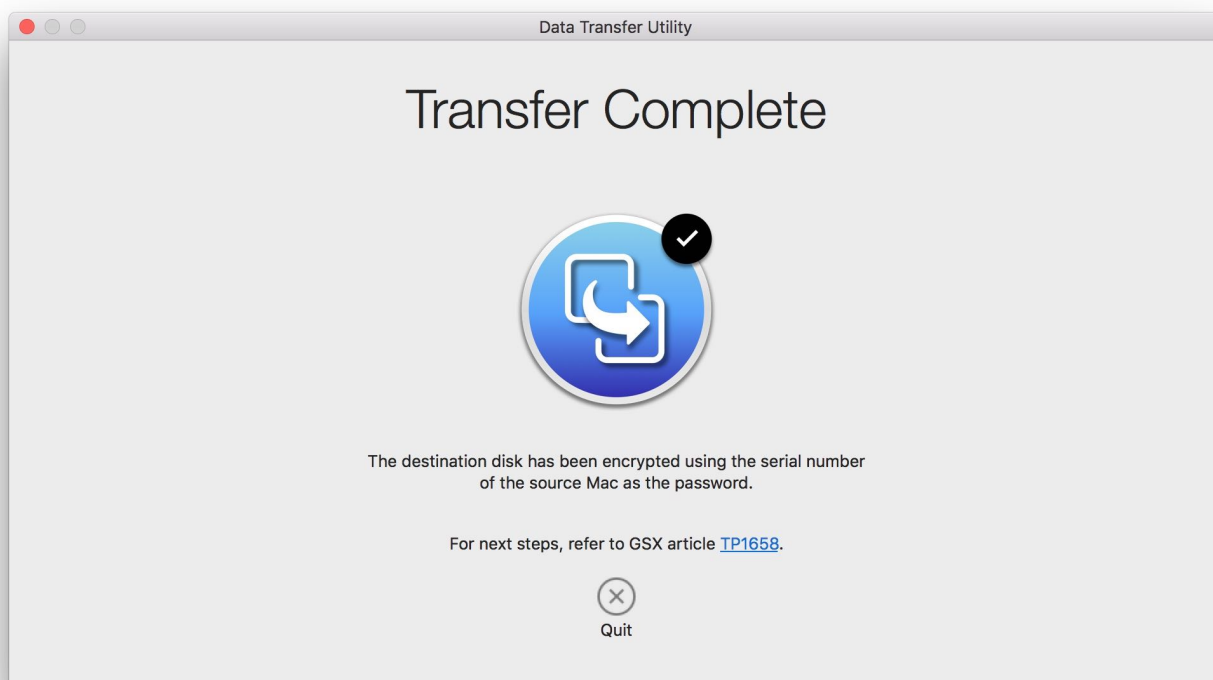


11. Click Erase and Transfer.

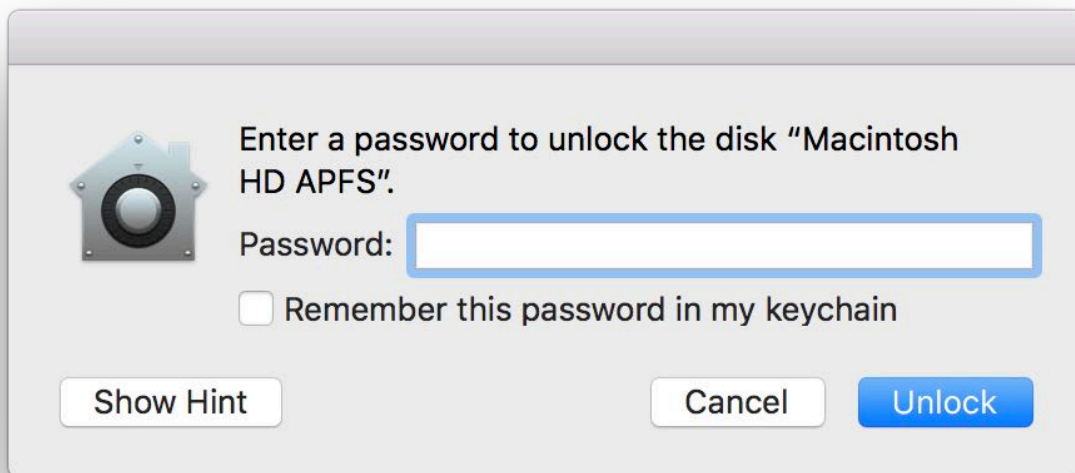


12. Transfer complete.

Important: Check the transfer is successful before closing the repair. Once the repair is closed this procedure cannot be performed again on the known bad (KBB) logic board.



13. Make sure the external drive is encrypted and the password works by unplugging it and plugging it back in.



Important: If the logic board has been replaced, data transfer using this process is no longer possible if System Configuration has been run and the repair has been closed.

Troubleshooting Tips:

If the Data Transfer Setup suite is unavailable, check the following:

1. Verify that the correct data migration part number has been added to the repair and saved.
2. Verify that the repair that includes the logic board has not been closed.
3. Verify that the correct serial number of the customer's computer was entered into the Diagnostic Console.
4. Verify that the serial number of the customer's computer was used to create the repair.
5. Verify that the device is correctly connected to the host Mac and that Mac Configuration Utility is running.
6. A correctly connected device will show as "Apple Mobile Device (DFU Mode)" in System Information > USB.
7. Do not use USB-C to USB-A cable (923-00504) combined with USB-C to USB Adapter (MJ1M2AM/A).

If the device does not complete the Data Transfer Setup suite, check the following:

1. Archive the AST 2 session, create a new one, and re-run the Data Transfer Setup suite.
2. Restart the host Mac.

If the Data Transfer Utility app does not show any volumes under Select Source Volume(s), check the following:

1. Verify volume(s) appear in Finder or Disk Utility.
2. Verify the correct serial number of the customer's computer was entered into the Data Transfer Utility app.

If the external hard drive is not being recognized by the Data Transfer Utility app, it may need to be initialized using Disk Utility.

Portables (Mid 2012 and later) Battery Safety Setup

Battery Safety Setup for MacBook and MacBook Pro (Mid 2012 and later)



Warning: Before servicing a portable computer, read and understand article [OP24: Safely handling lithium batteries and lithium battery-powered devices](#).

For information on how to set up your workstation, refer to article [OP685: Embedded battery workstation setup for Apple notebook computers and iPhone](#).

Battery Handling and Storage

Battery Handling and Storage for MacBook Pro (2016, 2017, 2018, 2019)

Best Practices

The battery contains several soft battery cells. Do not press the battery cells with your fingers, and do not handle the battery pack in any way that might apply any physical pressure to the cells.

- Always attach the battery cover to the battery immediately after removing the bottom case and before beginning any repair. Make sure all snaps on the battery cover are secure. Refer to the following list for battery cover part numbers:
 - MacBook Pro (13-inch, 2016, 2017, 2019 Two Thunderbolt 3 Ports): **923-01318**
 - MacBook Pro (13-inch, 2016 and 2017, Four Thunderbolt 3 Ports): **923-01319**
 - MacBook Pro (13-inch, 2018 and 2019, Four Thunderbolt 3 Ports): **923-02533**
 - MacBook Pro (15-inch, 2016 and 2017): **923-01320**
 - MacBook Pro (15-inch, 2018 and 2019): **923-02532**
- Disconnect the battery cable and remove the battery management unit (BMU) screw from the logic board whenever the bottom case is removed. Keep the battery cable disconnected and BMU screw removed during all part removal and reassembly. Reconnect the battery cable and reinstall the BMU screw just before installing the bottom case.
- Do not use a damaged battery cover. If the battery cover is damaged, replace it.
- Remove the battery cover just before installing the computer's bottom case. Keep the battery cover on the battery at all other times.
- Do not drop a top case assembly with battery. If the top case has been dropped, replace it.

Battery Covers

MacBook Pro (13-inch, 2016, 2017, and 2019 Two Thunderbolt 3 Ports): **923-01318**



MacBook Pro (13-inch, 2016 and 2017, Four Thunderbolt 3 Ports): **923-01319**



MacBook Pro (13-inch, 2018 and 2019, Four Thunderbolt 3 Ports): **923-02533**



MacBook Pro (15-inch, 2016 and 2017): **923-01320**



MacBook Pro (15-inch, 2018 and 2019): **923-02532**



Battery Inspection

Refer to [OP693: Visual battery inspection](#) for the latest visual inspection details.

Packaging a Top Case Assembly with Battery for Return

Important: Do not discard the top case packaging.

The same cardboard box and inner packaging used to ship a known-good top case assembly with battery must be used when returning it.



1. Verify that the packaging is in good condition: that labels are present, legible, and intact, and that the box is well structured and strong.



7. Place the top case with covered battery inside the bag.
8. Fold over the bag and seal it closed with the yellow ESD sticker. If the sticker is not available, use tape.
9. Place wrapped top case on bottom foam pad within inner foam frame inside cardboard box.
10. **Important:** When placing the wrapped top case in the box, make sure the battery is face up and at the front opening of the box.



11. Place the second foam pad over the wrapped top case.



11.

12. Close the box and seal it with tape. Do not use staples.



12.

13. Make sure the caution label and packing list are attached to the box.
14. Attach a shipping label and return the top case assembly with battery using normal shipping procedures.



14.

Butterfly Mechanism Keycap Replacement

Butterfly Mechanism Keycap Replacement for MacBook Pro (2018 and 2019)

With the new keycap lever tool, it is now easier and faster to replace keycaps for MacBook Pro computers with a butterfly mechanism. The butterfly mechanism keycap replacement procedure allows you to replace individual keycaps instead of the entire top case. You can complete the procedure in less than three minutes.

Note: There is also a new Space bar removal procedure for MacBook Pro (2018 and 2019). For video instructions on the Space bar removal procedure, refer to [SV372: MacBook Pro \(2018 and 2019\): Space Bar Keycap Lever Video](#).

Caution: The keyboard has a membrane under the keycaps that prevents debris from entering the butterfly mechanism. Be careful not to tear the membrane. A torn membrane requires a top case replacement.

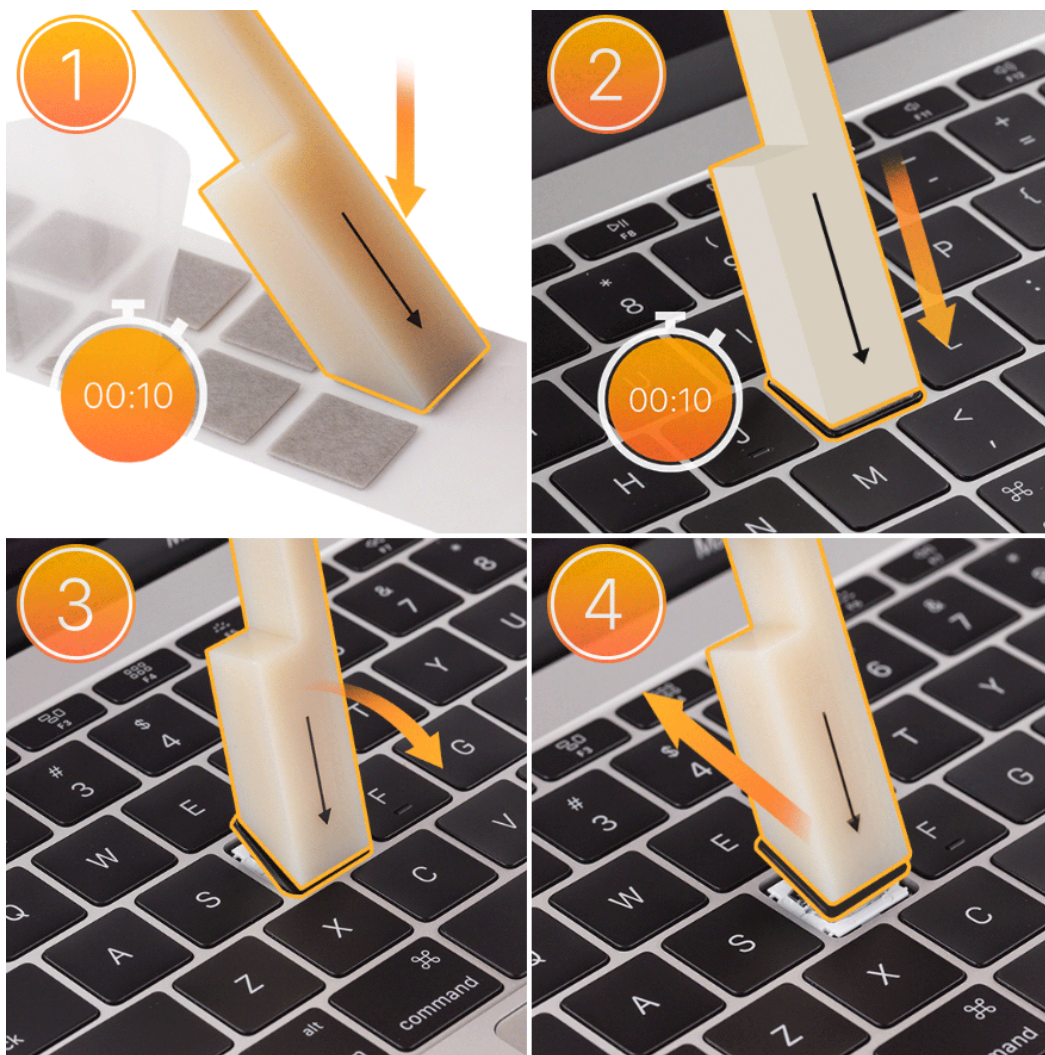


This is the quickest and most cost-effective procedure for fixing the following butterfly mechanism symptoms:

- Key stuck in up or down position
- Key press feels uneven or stiff
- Keycap not responding, is spongy, or is not going all the way down
- Key makes abnormal noise or metallic click sound

The procedure involves four basic steps:

1. Applying the adhesive to the keycap lever tool
2. Pressing and holding the keycap lever tool on the keycap for 10 seconds
3. Pulling the keycap in the correct direction to release snaps
4. Pushing the keycap in the opposite direction to release hooks



For video instruction, refer to [SV347: Portables Keycap Lever Video](#).

For part numbers, refer to the [Keycap Kit Part Numbers](#) section below.

For a guide on where to place the keycap lever tool when removing keycaps, refer to the [Keycap Lever Placement Map](#) section below.

For detailed information on the procedure, refer to the [Procedure for Removing and Replacing Keycaps](#) section below.

Note: If a keycap replacement does not resolve the issue, you must replace the entire top case. To confirm the correct keyboard country code and part number, refer to [HT201794: How to identify keyboard localizations](#). Use the exploded view in the service guide to confirm the correct top case part number before ordering a service part.

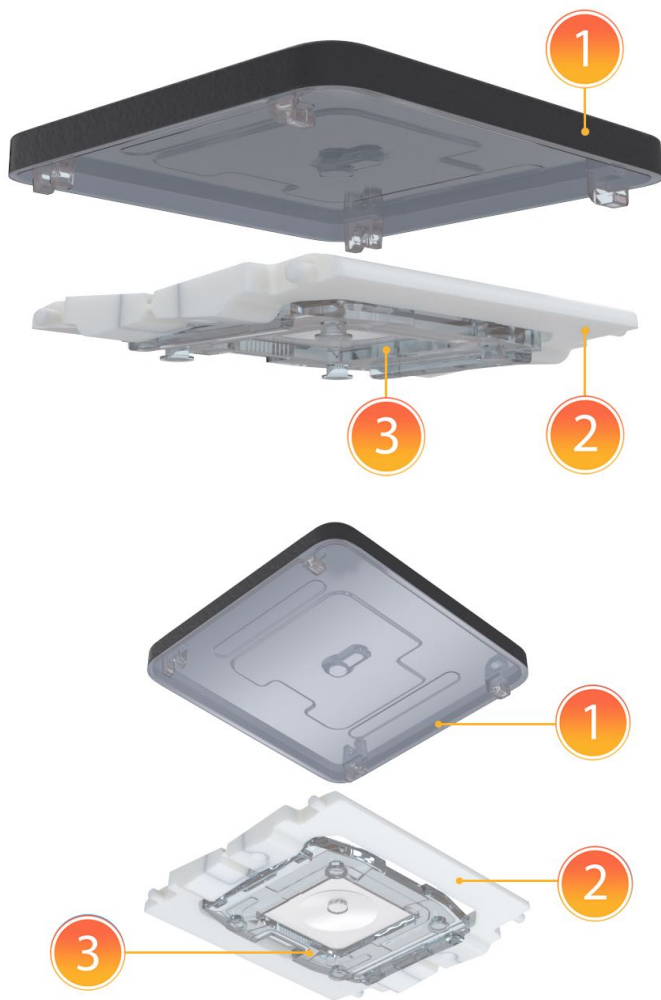
First Steps

- Refer to [OP2007: Keyboard Service Program for MacBook and MacBook Pro](#) for instructions on creating a keycap repair.
- Before replacing the keycap on an unresponsive keyboard, be sure to clean the keyboard thoroughly with compressed air. Then remove the keycap, spray the well with compressed air, and check for liquid damage.
- Always install a new keycap. Do not attempt to reinstall the keycap that was removed.
- For Arabic keyboards, the Return key may show uneven backlighting from top to bottom. This is expected behavior. Do not repair or replace for this issue.
- When replacing the Option key, make sure the removed Option key and the replacement Option key have the same glyphs. If they do not, replace both Option keys.

1. Keycap Anatomy

Keycap mechanisms consist of three parts. Only the keycap part is replaceable:

1. Keycap: the surface key that a user sees on the keyboard
2. Butterfly: the hinged piece under the keycap
3. Switch housing: the piece that secures the butterfly to the top case



Important: Keycaps are replaceable. Butterflies and switch housings are not replaceable. A damaged switch housing or butterfly requires a top case replacement.

If a keycap needs replacement due to accidental damage, such as a liquid spill, refer to [OP14: Determining and quoting accidental damage for Mac portables](#).

2. Keycap Kit Part Numbers

Important: Keycap kits vary by computer color and keyboard language.

To help determine keyboard localization or keycap placement, refer to [HT201794: How to identify keyboard localizations](#).

Notes:

- Keycap kits are available for UK English (ISO), U.S. English (ANSI), Chinese (ANSI), and Japanese (JIS) version keyboards.
- The Super ISO is a European special character kit that includes specific keycap characters for the following languages:
 - German (D)
 - French (F)
 - Danish (DK)
 - Italian (T)
 - Spanish (E)
 - Swedish (S)
- Common Kits include the following keycaps:
 - ANSI: Space bar, Left Shift, Right shift, Caps Lock, Delete, Tab, Return, Escape
 - JIS: Space bar, Return, Left Shift, Right Shift, 1, power
 - ISO: Space bar, Right Shift, Caps Lock, Delete, Tab, Return, Escape

MacBook Pro (13-inch, 2018 and 2019, Four Thunderbolt 3 Ports), MacBook Pro (15-inch, 2018 and 2019), and MacBook Pro (13-inch, 2019, Two Thunderbolt 3 Ports)

Part Number	Label Number	Language
923-02536	605-04207	ANSI English
923-02537	605-04208	ANSI English Common Kit
CH923-02536	CH605-04207	ANSI English, China
B923-02536	B605-02536	ISO British
ZM923-02536	ZM605-04207	Super ISO English
ZM923-02537	ZM605-04208	ISO English Common Kit
J923-02536	J605-04208	Japanese
J923-02537	J605-04208	Japanese Common Kit

3. Keycap Lever Placement Map

The following illustrations show where to place the keycap lever tool when removing keycaps.

Release the edge of the keycap at the snaps before releasing the edge with the hooks. For detailed instructions, refer to the [Procedure](#) section below.



Yellow: The hooks are on the bottom and the snaps are on the top.



Blue: The hooks are on the right and the snaps are on the left.



Orange: There are four snaps on the top and four hooks on the bottom.



Purple: The hooks are on the left and the snaps are on the right.



Green: There are three hooks on the bottom and three snaps on the top.

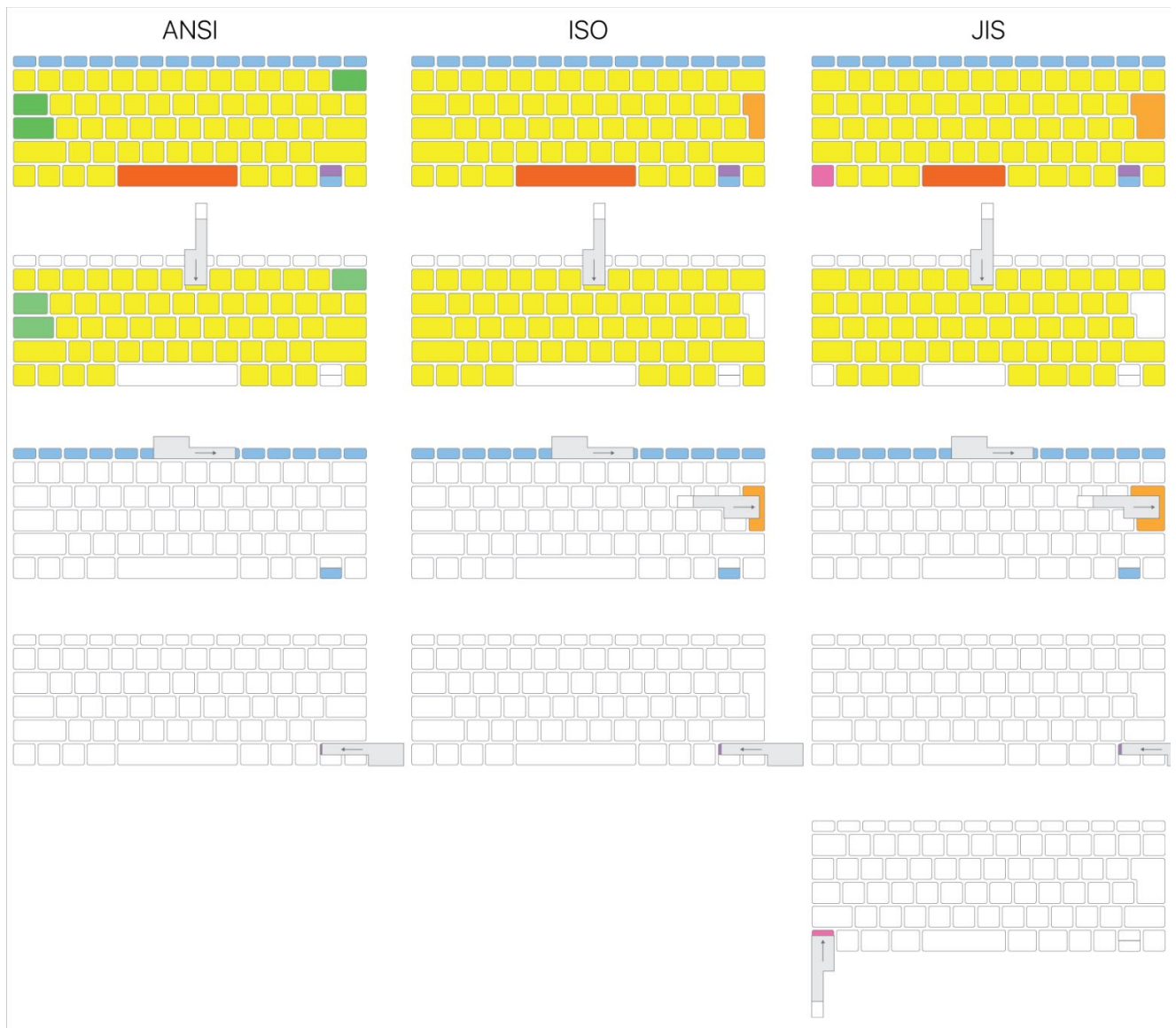


Light Orange: There are three hooks on the right and three snaps on the left.



Pink (Japan only): The hooks are on the top and the snaps are on the bottom.

Click on an image below to enlarge it.

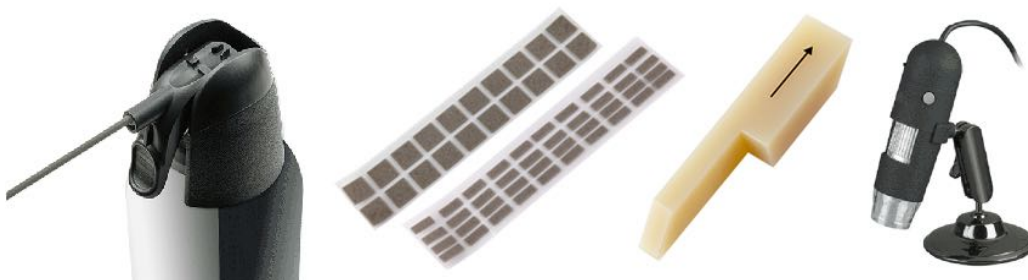


4. Procedure for Removing and Replacing Keycaps

Caution:

- Shut down the computer before replacing a keycap.
- Press the keycap lever very gently on the keycap when initializing the VHB adhesive strip. The top case should not bend when pressing the keycap lever onto the keycap. Too much pressure can damage the butterfly.
- A damaged butterfly requires a top case replacement.
- Inspect the switch housing with a USB microscope. If the pockets are damaged, replace the top case. Refer to step 9 of Section 4A.

Tools:



- Compressed air
- Precut VHB Strips (923-01801, 1x1; 923-01800, 1x.5)
- Keycap Lever (923-01803) **Note:** This tool is double sided. The large side is for yellow, pink, and green keys; the smaller side is for blue, light orange, and purple keys. This tool is not to be used for the Space bar (orange keys).
- USB Microscope

- Keycap Lever Kit (076-00337) includes: Keycap slider, keycap lever, Kapton tape, and precut VHB strips

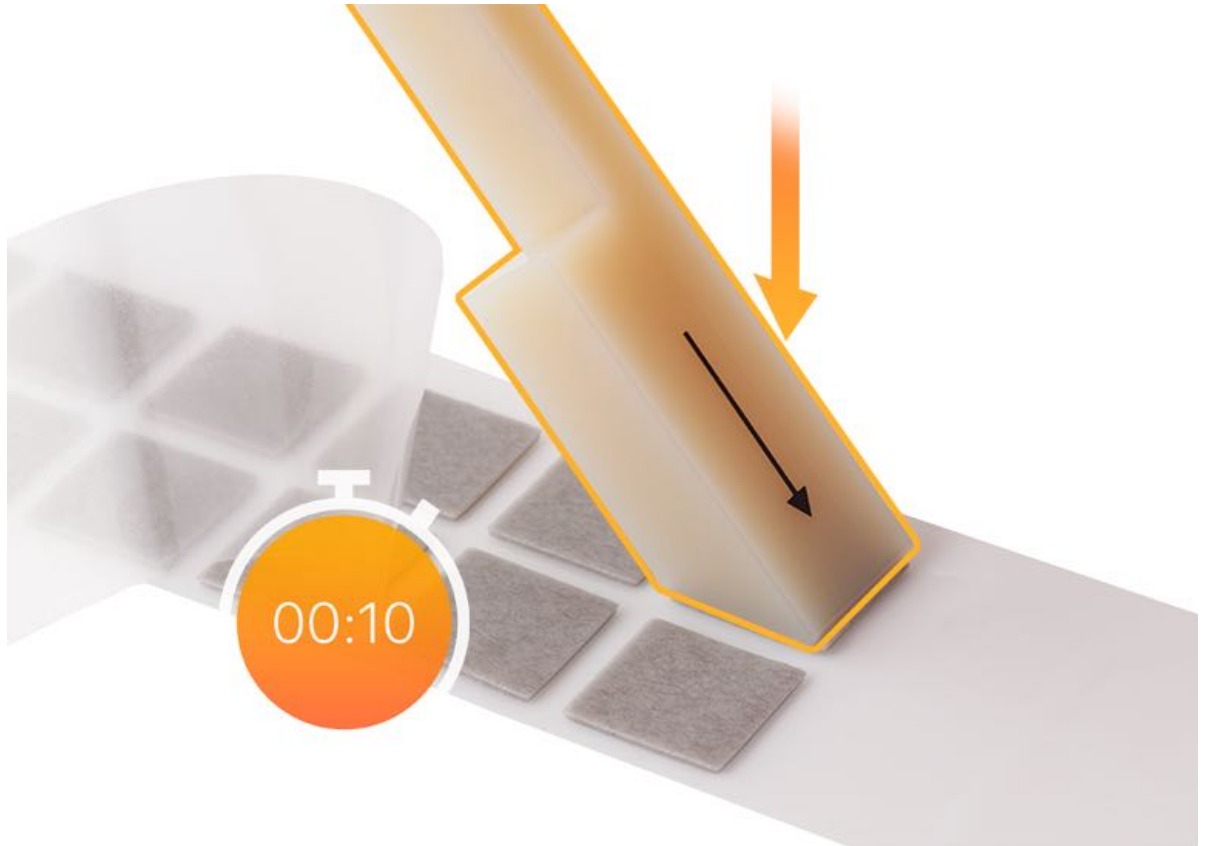
Note: Before attempting this procedure for the first time, practice on a known-bad top case and keyboard with a butterfly mechanism.

Follow these steps to remove and replace a keycap.

There are four types of keys on the keyboard. Each type of key requires a different procedure.

A. Removing and Replacing Yellow, Green, and Pink Keys

1. Peel back the frosted liner from one side of the precut VHB strip. Press the large end of the keycap lever onto the 1x1 adhesive and hold for 10 seconds.



2. Lift the keycap lever, with the adhesive attached, from the clear liner.
3. Lightly press the keycap lever with the adhesive side down, onto the key, aligning the arrow on the tool with the hooks on the keycap. Refer to the [Keycap Lever Placement Map](#) above for hook locations.

Note:

- On the larger keys such as Caps Lock, Return, Shift, Tab, Delete, Command, place the keycap lever in the middle of the key.
- The adhesive is very strong. If the keycap lever is accidentally placed onto the wrong keycap, continue with the removal process and replace with a new keycap.



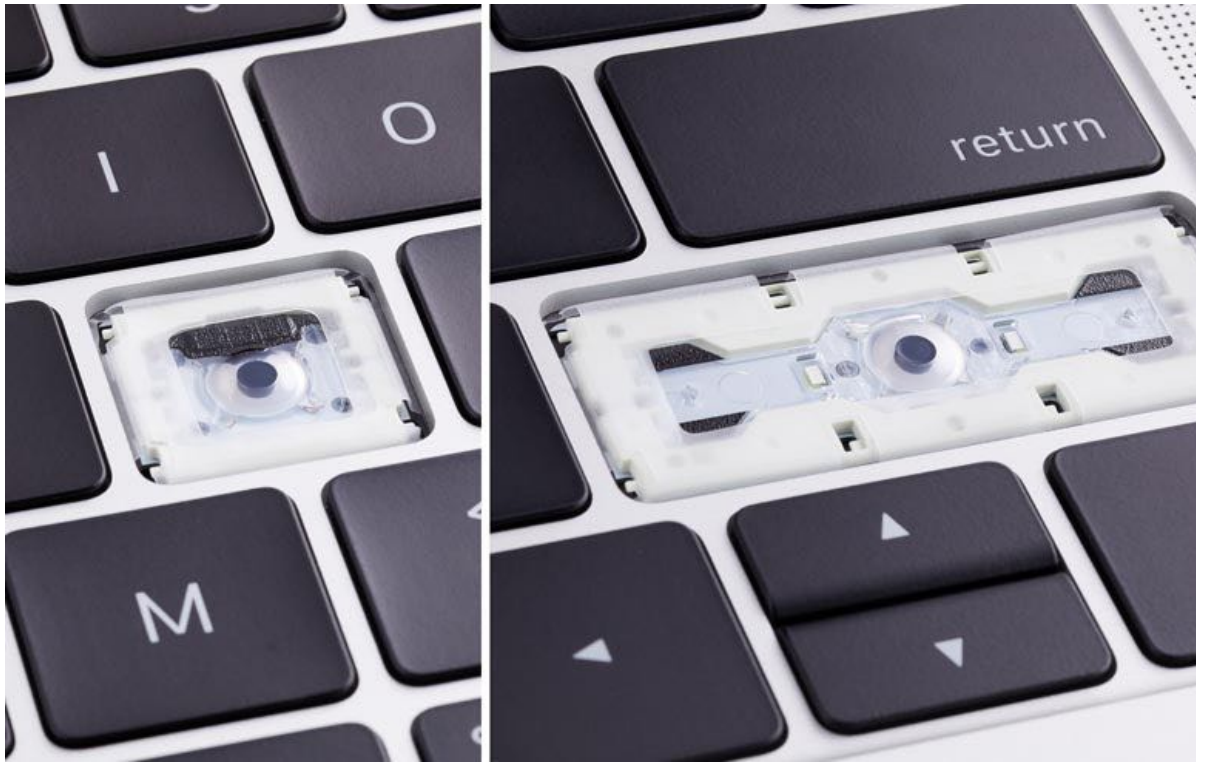
6. Push the lever tool up towards the display to unhook the keycap hooks and remove the keycap.



7. Remove the keycap and the adhesive from the keycap lever and discard both. **Note:** The adhesive is one-time use only and must be replaced for every keycap removal.

8. Use compressed air to clean the keycap well. **Note:** If compressed air does not dislodge visible debris, use a black stick to gently dislodge the debris.

9. Visually inspect the membrane to be sure it is intact and not damaged, torn, or folded. If the membrane is damaged or torn, replace the top case.



10. If the membrane is folded under the butterfly mechanism, use a black stick to gently untuck it. Be careful not to tear the membrane. The membrane is most likely to become tucked at the corners of the butterfly mechanism.

11. Always replace the removed keycap with a new one. Do not reuse keycaps. Insert the bottom of the keycap into the well at a 15-degree angle and gently push to engage the hooks.

12. Gently push down on the top of the keycap to engage the snaps. If the keycap is not lined up properly, the snaps will not engage. If this happens, start again.

13. Check the key from all angles to make sure it is uniformly flat. Tap the key repeatedly to verify that it springs back each time. Compare the response of the new keycap with the response of the keycaps around it.

B. Removing and Replacing the Up Arrow Keys (Purple), ISO and JIS Return Keys (Light Orange), and the Function and Down Arrow Keys (Blue)

Removing the Up Arrow Key

1. Peel back the frosted liner from one side of the precut VHB strip. Press the small end of the keycap lever onto the 1x.5 adhesive and hold for 10 seconds.



2. Lift the keycap lever, with the adhesive attached, from the clear liner.

3. Lightly press the keycap lever, with the adhesive side down, onto the Up Arrow key, aligning the arrow with the hooks on the left side.

Note: The adhesive is very strong. If the tool is accidentally placed onto the wrong keycap, you must continue with the removal process and replace with a new keycap.

4. Hold for about 10 seconds to activate the adhesive.



5. Pull the keycap lever to the left to unsnap the keycap. Stop when you hear a

click.



6. Then push the keycap lever slightly forward to unhook the hooks and lift up to remove the keycap.



7. Remove the keycap and the adhesive from the keycap lever and discard both. **Note:** The adhesive is one-time use only and needs to be replaced for every keycap removal.

Removing the Down Arrow Key, ISO and JIS Return Keys, and Function Keys

1. Peel back the frosted liner from one side of the precut VHB strip. Press the small end of the keycap lever onto a 1x.5 adhesive and hold for 10 seconds.



2. Lift the keycap lever, with the adhesive attached, from the clear liner.

3. Lightly press the keycap lever, with the adhesive side down, onto the Down Arrow key or Function key, aligning the arrow with the hooks on the right side.

Note: The adhesive is very strong. If the keycap lever is accidentally placed onto the wrong keycap, continue with the removal process and replace with a new keycap.

4. Hold for about 10 seconds to activate the adhesive.



5. Slowly pull the keycap lever to the right to unsnap the keycap. Stop when you hear a click.



6. Push the keycap lever slightly forward to unhook the hooks, and lift up to remove the keycap.



7. Remove the keycap and the adhesive from the lever and discard both. **Note:** The adhesive is one-time use only and needs to be replaced for every keycap removal.

Replacing the Arrow Keys, ISO and JIS Return Keys, and Function Keys

1. Visually inspect the butterfly. Be sure the pins are properly seated and have not popped out of place.
2. Visually inspect the membrane to be sure it is intact and not damaged, torn, or folded. If the membrane is damaged or torn, replace the top case.



3. If the membrane is folded under the butterfly mechanism, use a black stick to gently untuck it. Be careful not to tear the membrane. The membrane is most likely to become tucked at the corners of the butterfly mechanism.
4. Always replace the keycap with a new one. Do not reuse keycaps.

- For Up Arrow, insert the right side of the keycap into the well at a 15-degree angle and gently push to engage the hooks.
- For Down Arrow and Function, insert the left side of the keycap into the well at a 15-degree angle and gently push to engage the hooks.

5. Gently push down on the left side of the keycap to engage the snaps. If the keycap is not lined up properly, the snaps will not engage. If this happens, start again.

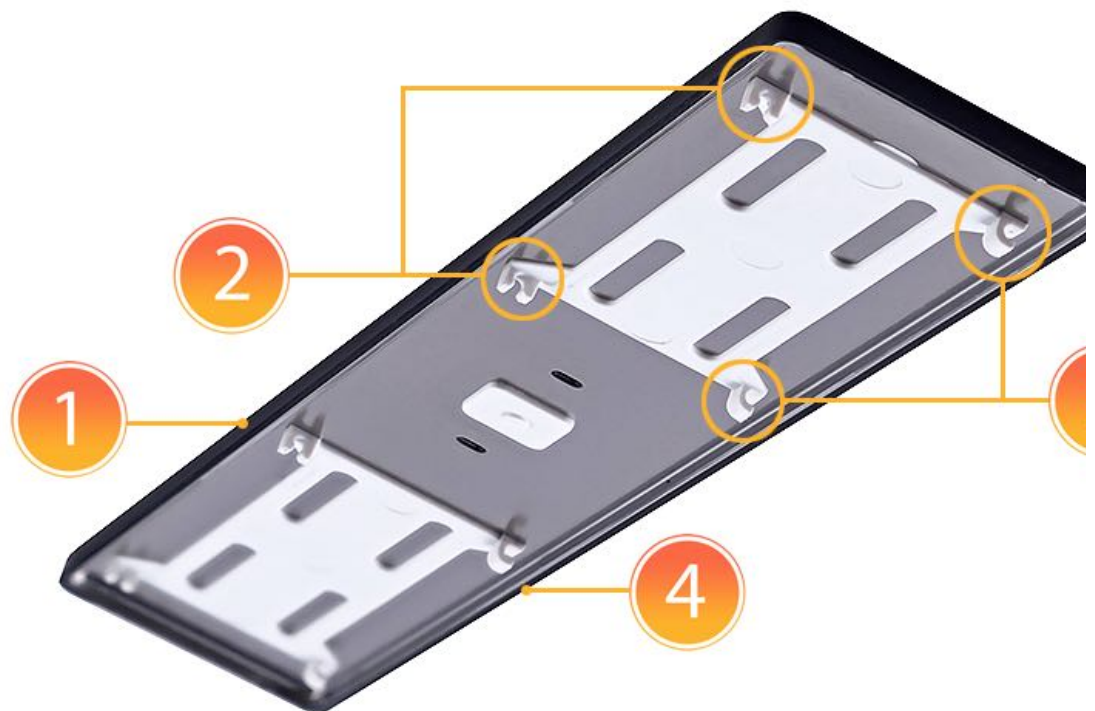
6. Check the key from all angles to make sure it is uniformly flat. Tap the key repeatedly to verify that it springs back each time. Compare the response of the new keycap with the response of the surrounding keycaps.

C. Removing and Replacing the Space Bar Key (Orange)

Note:

- This is a new procedure for the Space bar. This procedure applies only to MacBook Pro (2018).
- Three keycap lever tools are needed for this procedure; one for alignment and two to be used as levers.
- The Space bar key has four hooks near its bottom edge and four snaps near its top edge. You must release all snaps and hooks to remove the Space bar. Do not lift from the middle of the key.

1. Display side (top of Space bar)
2. Snap
3. Hook
4. Trackpad side (bottom of Space bar)



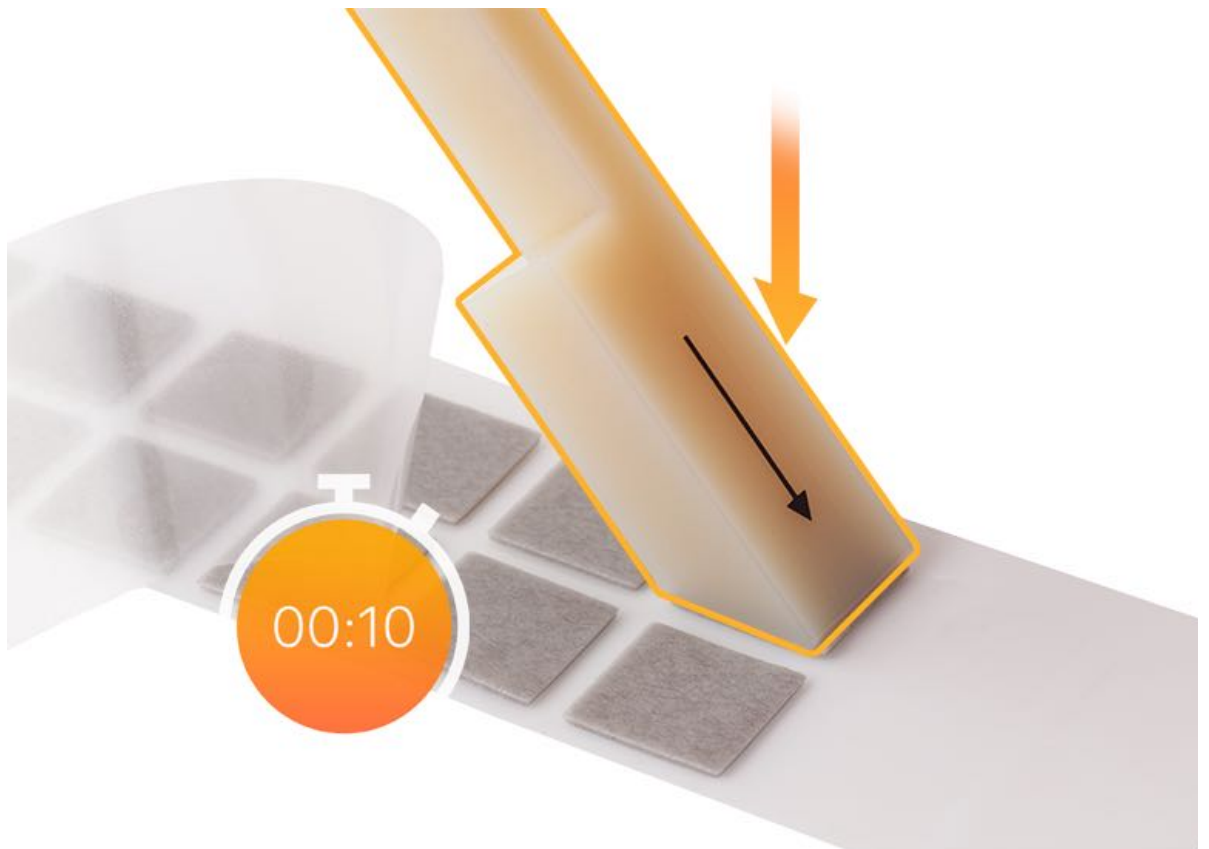
- Be careful not to tear the membrane.



1. To determine where to adhere the keycap levers on the Space bar, lay one keycap lever on its side (arrow either facing left or right, not facing up or down), and align it with the short edge of the Space bar.



2. Peel back the frosted liner from one side of the precut VHB strip. Press the large end of the keycap lever onto the 1x1 adhesive and hold for 10 seconds.



3. Lift the keycap lever, with the adhesive attached, from the clear liner.
4. Lightly press the keycap lever, with the adhesive side down, onto the Space bar next to the lever tool used for alignment. Hold for about 10 seconds.



5. Place the keycap lever that is being used for alignment on the opposite edge of the Space bar.



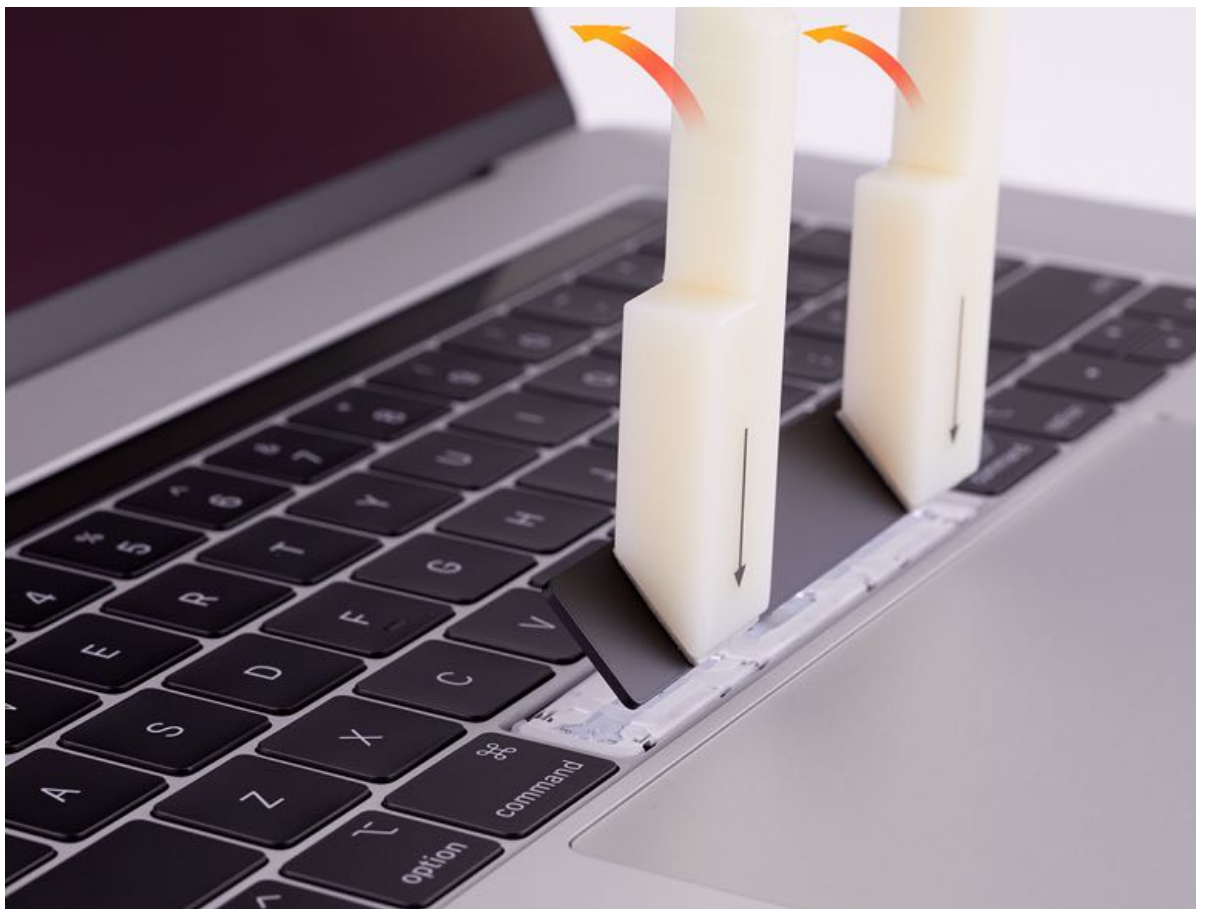
6. Repeat instructions to place adhesive on the keycap lever and then gently place the third keycap lever on the Space bar next to the keycap lever being used for alignment. Hold for about 10 seconds.



7. Simultaneously pull both keycap levers toward you to disengage the snaps. You will hear the snaps disengage.



8. Simultaneously lift the levers toward the display to disengage the hooks and remove the keycap.



9. Use compressed air to clean the well. **Note:** If compressed air does not dislodge visible debris, use a clean cloth to gently dislodge the debris.

10. Visually inspect the membrane to be sure it is intact and not damaged, torn, or folded. If the membrane is damaged or torn, replace the top case.

11. If the membrane is folded under the butterfly mechanism, use a black stick to gently untuck it. Be careful not to tear the membrane. The membrane is most likely to become tucked at the corners of the butterfly mechanism.



12. Always replace the keycap with a new one. Do not reuse keycaps.

13. Install the replacement Space bar using two hands, not tools. Engage the four front hooks first.



14. Tilt the Space bar toward the display and gently push down on the top of the keycap and run your finger across the top of the Space bar to engage all four snaps. **Note:** If the keycap is not properly aligned, the snaps will not engage. If this happens, start again.

15. Check the key from all angles to make sure it is uniformly flat. Tap the key repeatedly to verify that it springs back each time. Compare the response of the new keycap with the response of the surrounding keycaps.

Visual/Mechanical Inspection (VMI) Guide for Mac Computers - Table of Contents

Visual/Mechanical Inspection (VMI) Guide for Mac Computers - Table of Contents

- [Mac Displays](#)
- [Liquid Damage](#)
- [Power Adapters](#)
- [USB-C Cables](#)

Liquid Contact Indicators

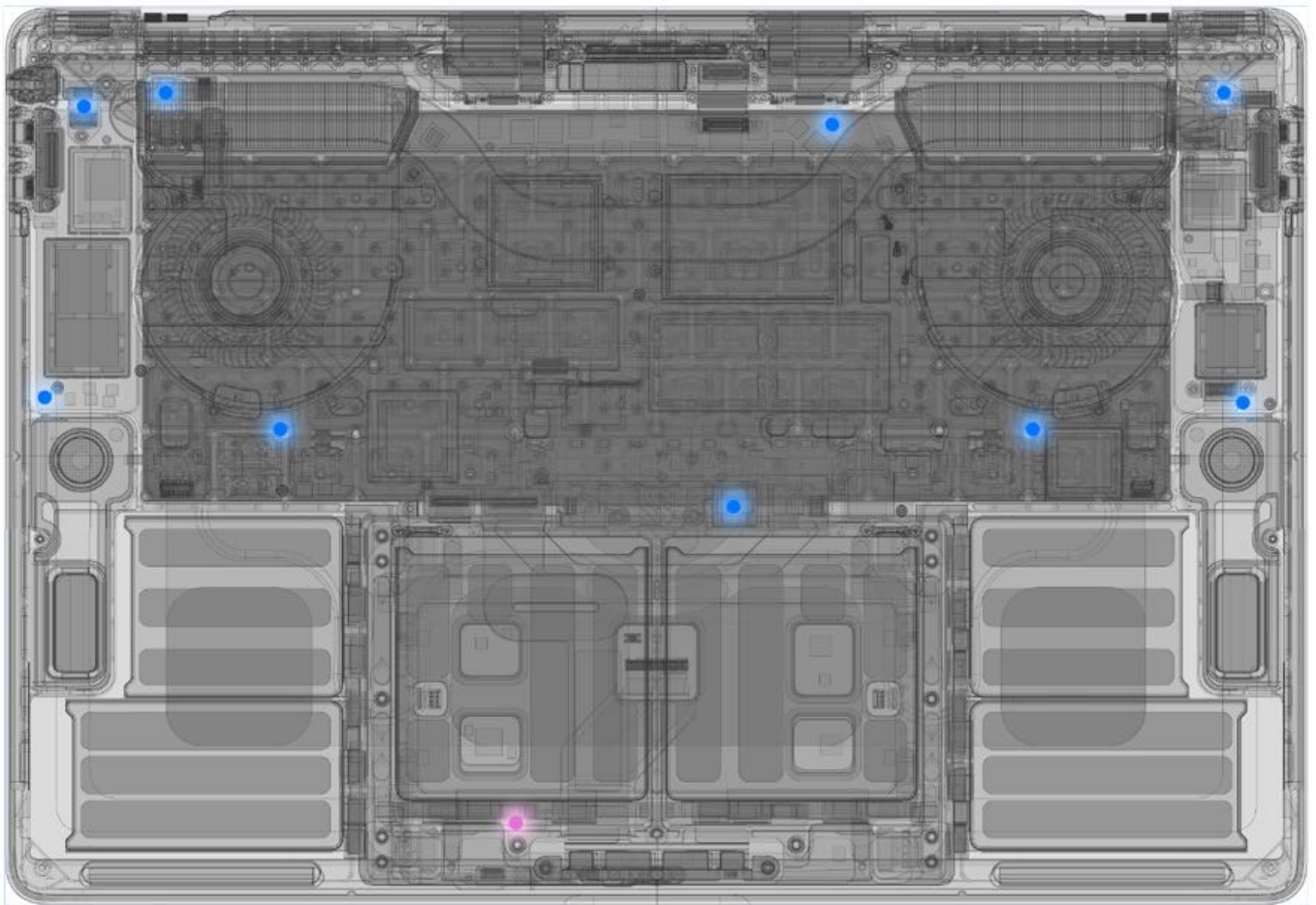
Liquid Contact Indicators for MacBook Pro (Retina, 15-inch, 2018 and 2019)

Liquid Contact Indicators (LCIs) help determine if a computer has been exposed to liquid. Represented by small white (traditional LCIs) or black (Ultraviolet LCIs) dots, LCIs change color when they come in contact with liquid, such as an accidental spill. For more information on how to read Ultraviolet (UV) LCIs, refer to [TP1557: How to Read Liquid Contact Indicators with Ultraviolet \(UV\) Light](#).

Important: A LCI is a tool that helps technicians identify if a product has been in contact with liquid. Technicians should not rely solely on this tool, but should perform a thorough examination for signs of liquid contact, such as corrosion.

For more information, refer to [HT204769: Mac computers: About liquid contact indicators \(LCIs\) and warranty coverage](#).

- Blue circles represent UV LCIs
- Pink circles represent traditional LCIs



How to Read Liquid Contact Indicators with Ultraviolet (UV) Light

How to Read Liquid Contact Indicators with Ultraviolet (UV) Light

MacBook (Retina, 12-inch, 2017), MacBook Air (Retina, 13-inch, 2018 and 2019), and MacBook Pro (2018 and 2019) contain spill sensors called liquid contact indicators (LCIs). LCIs help discover accidental damage to the computer. They are black, and liquid contact is only visible with the use of a UV light. LCIs appear black under normal light and glow blue when highlighted with a UV light. They turn pink or produce a pink halo when they come in contact with liquid.

Note: MacBook Pro (15-inch, 2018 and 2019) also has one LCI that appears white and turns pink when it comes in contact with liquid. Refer to [TP1660: Liquid Contact Indicators](#).

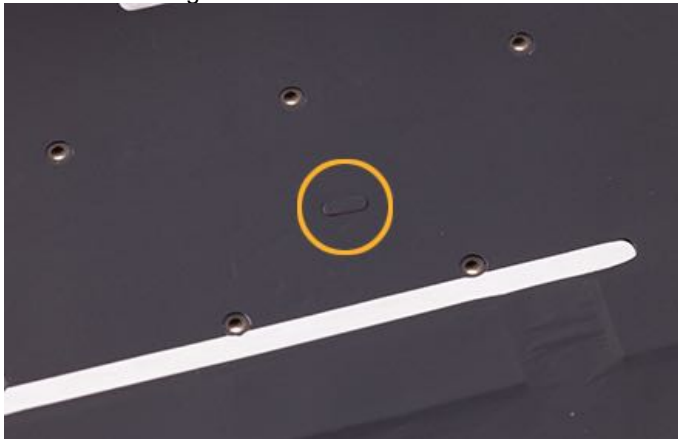
For more information, refer to [HT204769: About liquid contact indicators \(LCIs\) and warranty coverage](#).

For video instruction, refer to [SV348: Using UV Light to Read LCIs Video](#).

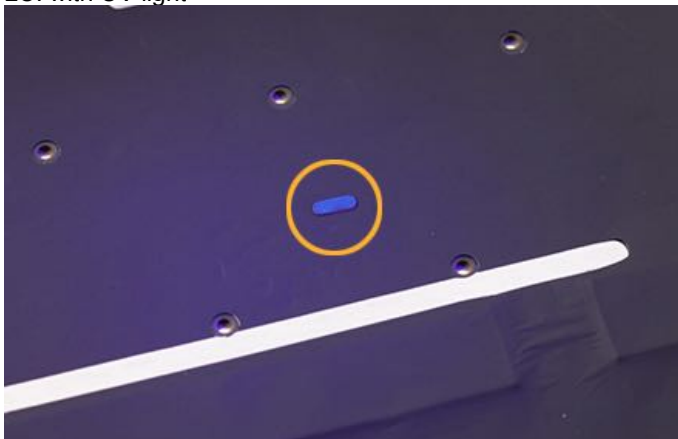
Important: A triggered LCI is not the only evidence of liquid contact. Be sure to inspect for corrosion or liquid residue during a quick check or repair. Refer to [TP1150: Visual/Mechanical Inspection \(VMI\) Guide for Mac Liquid Damage](#) for instructions on how to inspect for liquid damage.

No Liquid Contact:

- LCI without UV light

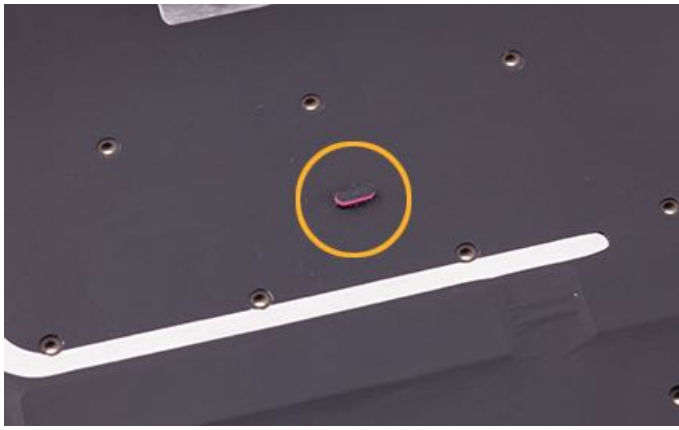


- LCI with UV light

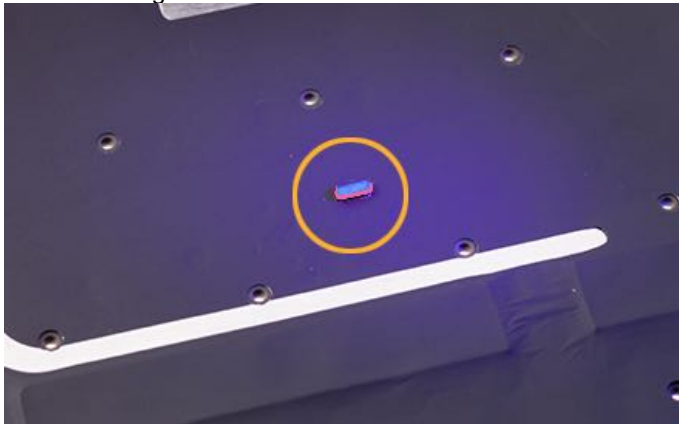


Liquid Contact:

- LCI without UV light



- LCI with UV light



Safety Information:

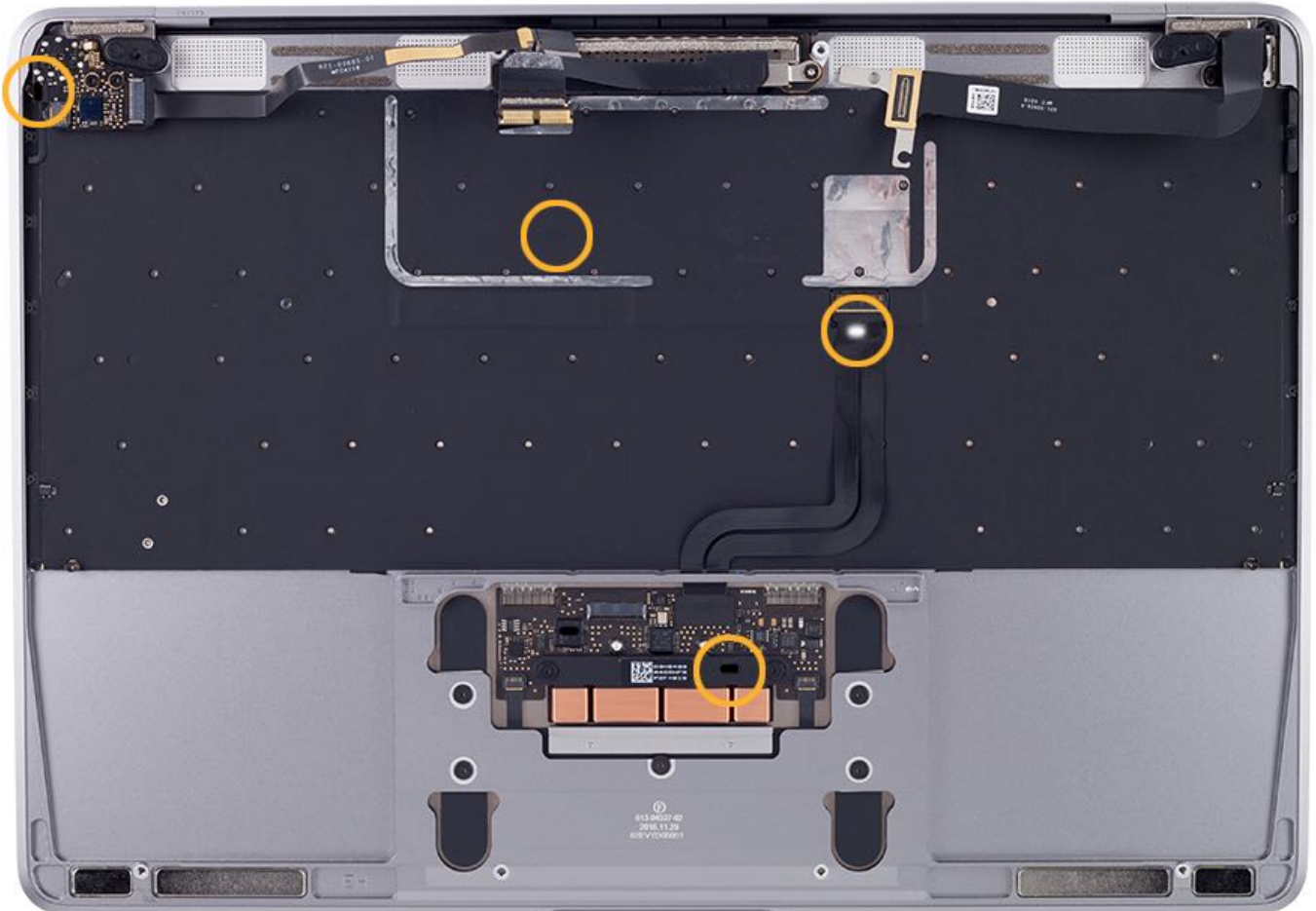
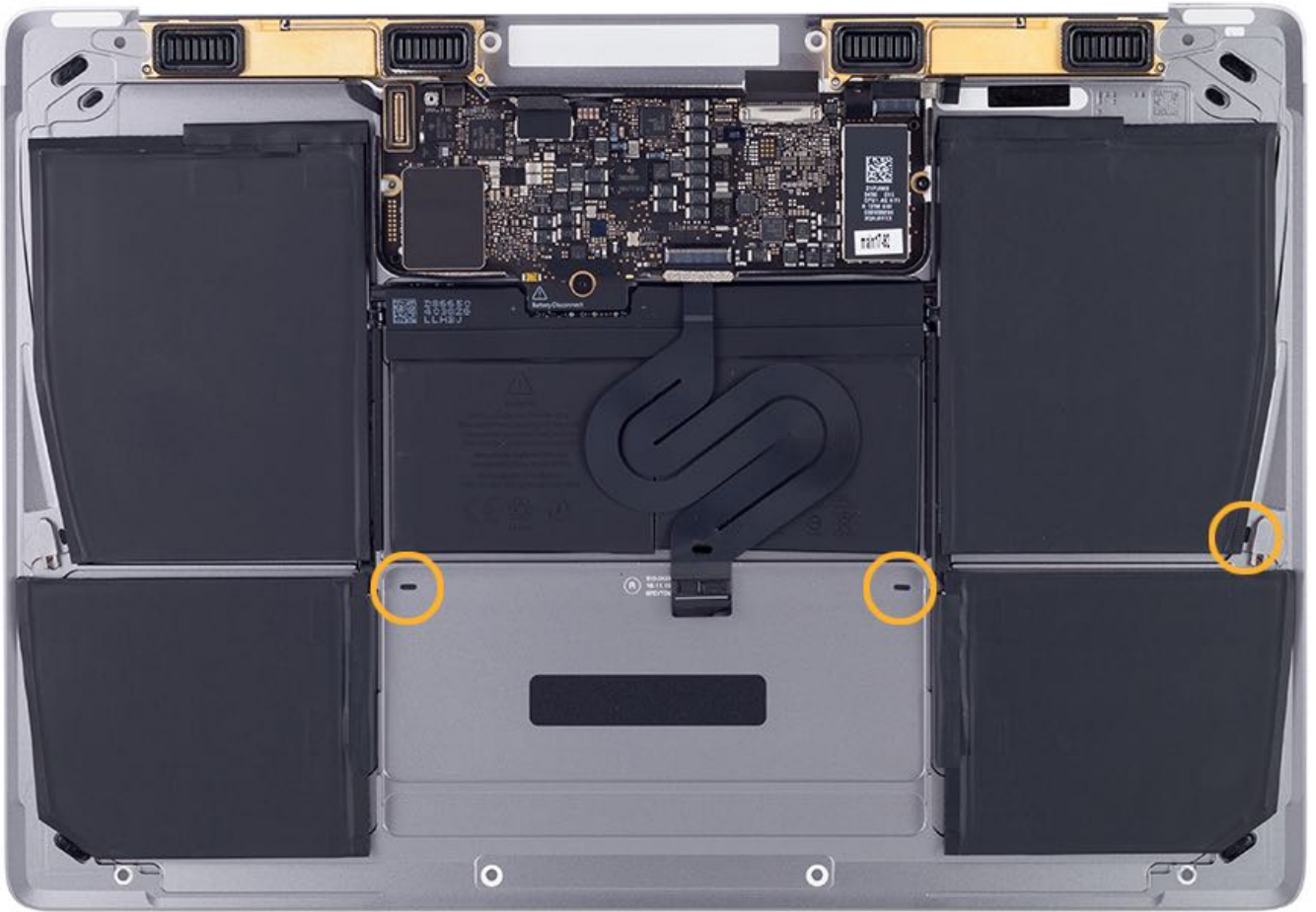
Caution: UV LCIs illuminate with the use of the Apple-approved UV light (923-01604). Follow safety precautions when using this tool:

- Do not remove the warning labels on the UV light.



- Do not shine the UV light in anyone's eyes or face.
- Avoid repeated exposure to the UV light.
- If a different UV light is used, safety glasses and gloves must be worn to avoid excessive exposure.

The following images show the general location of LCIs in a MacBook computer.



For the location of LCIs in MacBook Air (Retina, 13-inch, 2018 and 2019) and MacBook Pro (2018 and 2019) models, refer to the following articles:

- [TP1691: MacBook Air \(Retina, 13-inch, 2018 and 2019\): Liquid Contact Indicators](#)

- [TP1661: MacBook Pro \(13-inch, 2018 and 2019, Four Thunderbolt 3 Ports\): Liquid Contact Indicators](#)
- [TP1660: MacBook Pro \(15-inch, 2018 and 2019\): Liquid Contact Indicators](#)

Procedure

Note:

- Ultraviolet LCIs are black. The black LCIs blend in with the rest of the computer. When in contact with liquid, the LCIs may swell and become easier to identify.
- When using the UV light, hold it 12 to 14 inches (30 to 35 centimeters) from the computer and shine it at an angle of 15 to 75 degrees.



Warning: While the UV light is shining, do not hold it close to your face or bend your head down to look closely at the LCIs.



1. Press the power button on the UV light.



2. Check the color of the LCI. Blue indicates an LCI that has not been triggered. A pink LCI or a pink halo around the LCI indicates that it has been triggered. Refer to visual examples at the top of this article.

General Troubleshooting

Update Software and Firmware

Important: Before troubleshooting, ensure the correct version of macOS is installed, and check for and apply the latest software and firmware updates. Computers sometimes exhibit symptoms that indicate the incorrect version of macOS is installed. Refer to [HT201686: Use the Mac operating system that came with your Mac, or a compatible newer version](#) to make sure system build is correct for this computer model.

Firmware refers to software that is written into memory circuits such as flash memory, which will hold the software code indefinitely, even when power is removed from the hardware. Firmware on Intel-based Mac computers prior to computers with an Apple T2 Security Chip is designed to be updated if necessary by running macOS Software Update (available in the Apple () menu under About This Mac) while the computer is connected to the Internet.

For computers with an Apple T2 Security Chip, separate SMC and EFI firmware images have now both been integrated into bridgeOS.

Troubleshooting Techniques

For more information, go to [ATLAS](#) and enter “troubleshooting” in the search field.

Hardware versus Software

To isolate a hardware issue from a software issue, refer to [HT203161: Isolating issues in macOS](#).

To troubleshoot a software issue, refer to the following articles:

- [HT201516: How to troubleshoot a software issue](#)
- [HT201861: About incompatible software on your Mac](#)
- [HT204323: If a flashing question mark appears when you start your Mac](#)
- [HT204904: How to reinstall macOS from macOS Recovery](#)
- [HT202574: About Fusion Drive, a storage option for some Mac computers](#)

Quick Check Procedures

System Configuration for Macs with the Apple T2 Security Chip

Important: For Macs with the Apple T2 Security Chip, the repair process is not complete for certain part replacements until the AST 2 System Configuration suite has been run. Failure to perform this step will result in an inoperative system and an incomplete repair. Refer to [TP1657: System Configuration for Macs with the Apple T2 Security Chip](#).

Computer Model	Logic Board	Top Case	Display	Touch ID	Flash Storage
iMac Pro (2017)	•				•
Mac mini (2018)	•				
MacBook Air (Retina, 13-inch, 2018)	•			•	
MacBook Air (Retina, 13-inch, 2019)	•		•	•	
MacBook Pro (13-inch, 2019, Two Thunderbolt 3 Ports)	•	•	•	•	
MacBook Pro (13-inch, 2018, Four Thunderbolt 3 Ports)	•	•	•	•	
MacBook Pro (13-inch, 2019, Four Thunderbolt 3 Ports)	•	•	•	•	
MacBook Pro (15-inch, 2018)	•	•	•	•	
MacBook Pro (15-inch, 2019)	•	•	•	•	

Resetting the System Management Controller (SMC)

The System Management Controller (SMC) is a chip on the logic board that controls all power functions. On some Mac computers, the Apple T2 Security Chip integrates several controllers—such as the SMC, image signal processor, audio controller, and SSD controller. If the computer is experiencing any power issue, such as not starting up, not displaying video, sleep issues, or fan noise issues, resetting the SMC may resolve it.

For more information and instructions to reset the SMC on different computer models, refer to [HT201295: How to reset the System Management Controller \(SMC\) on your Mac](#).

Note for iMac: If the power button is pressed while the power cord is being inserted, the iMac will enter a mode that runs the fans at full speed. For more information, refer to [HT204463: If the fans in your Mac run at full speed when you turn it on](#).

Note for iMac Pro (2017): If the power button is pressed while the power cord is being inserted, the iMac will enter Device Firmware Upgrade (DFU) mode and will need to be restored.

Resetting Nonvolatile RAM (NVRAM)

NVRAM stores certain system and device settings in a location that macOS can access quickly. Exactly which settings are stored in the computer's NVRAM varies depending on the type of computer, connected devices, and drives. To reset NVRAM:

For information, refer to [HT204063: Reset NVRAM or PRAM on your Mac](#).

Starting Up in Safe Mode

Safe mode (sometimes called safe boot) is a way to start up a Mac so that it performs certain checks and prevents some software from automatically loading or opening. These changes can help resolve or isolate certain issues on the startup disk.

For information, refer to [HT201262: Use safe mode to isolate issues with your Mac](#).

Recovering a Lost Firmware Password

Only technicians at Apple Stores or Apple Authorized Service Providers can unlock the following Mac models when they are protected by a firmware password:

- iMac (Mid 2011) and later
- iMac Pro (2017)
- MacBook (Retina, 12-inch, Early 2015) and later
- MacBook Air (Late 2010) and later
- MacBook Pro (Early 2011) and later
- Mac mini (Mid 2011) and later
- Mac Pro (Late 2013)

Refer to the technician instructions in [HT204455: How to set a firmware password on your Mac](#).

Sleep Status Tips

Sleep Status Tips for MacBook (Retina, 12-inch, Early 2015 and later) and MacBook Pro (2016 and later)

These computer models do not have a sleep indicator light. To troubleshoot without one:

- Press and hold the Caps Lock key to wake the computer from sleep. The Caps Lock indicator light is a good indication of power.
- Check the haptic response of the trackpad. The trackpad will not have any haptic response when there is no power to the system, except for 2018 and 2019 models which will show a response even with no power.
- Open the display and press an alphanumeric key to wake the computer from sleep.
- A computer that has been in sleep mode for an extended period can consume the remaining battery charge. Restore power to the computer with a known-good power adapter. The computer will start up from a hibernation file and start up from where it left off.
- Use a USB-C to USB Adapter, USB-C Digital AV Multiport Adapter, or USB-C VGA Multiport Adapter to connect a USB device that has a power-on or activity indicator light. As power is restored to the USB and the computer wakes from sleep, the indicator light illuminates.

Note: A USB-C to USB adapter may be used if power does not need to be supplied to the computer.

- Resetting the System Management Controller (SMC) instantly shuts down the computer, with some side effects:
 - If the computer is in sleep mode, it will start up from a hibernation file.
 - If the computer is running OS X or macOS during the SMC reset, data from open applications can be lost.
 - If the computer is already shutdown, there will be no side effects.

MacBook Pro (13-inch, 2018 and 2019, Four Thunderbolt 3 Ports), MacBook Pro (13-inch, 2019, Two Thunderbolt 3 Ports), MacBook Pro (15-inch, 2018 and 2019), and MacBook Air (Retina, 13-inch, 2018 and 2019)

The troubleshooting steps listed above still apply for these computer models. Pressing any key or the trackpad, connecting to a power adapter, and opening the display will also start these computer models. Note the following behaviors when the computer is shutdown and the battery has some remaining charge:

- The Caps Lock indicator light may illuminate when pressed.
- The trackpad will provide a haptic response when pressed.
- The computer will start up when the display is opened.
- The computer will start up when the display is open and it is connected to a power adapter.

For more information, refer to [HT201150: How to turn your Mac on or off](#).

Diagnostic Software

Apple Service Toolkit 2 (AST 2)

AST 2 is a cloud-based diagnostic system that helps technicians triage and verify repairs for iOS devices and Mac computers released in June 2014 and later, except for MacBook Pro (Retina, Mid 2014). Technicians use AST 2 to initiate diagnostics wirelessly on a user's device using the Diagnostic Console (a web application on a Mac or iPad). Technicians can also view diagnostic results on the Diagnostic Console.

For computers with the Apple T2 Security Chip, System Configuration (found in AST 2) must be run after certain repairs for the repair to be complete. Failure to do so will result in an inoperative system and an incomplete repair. Refer to [TP1657: System Configuration for Macs with the Apple T2 Security Chip](#) for more information.

An MRI (OS) diagnostic suite is available only for Mac notebook computers with the Apple T2 Security Chip.

For more information, refer to the following articles:

- [OP476: Latest Apple Service Toolkit download links and documentation](#)
- [TP1105: AST 2 for Mac Reference Guide - Table of Contents](#)
- [TP1118: AST 2 for Mac Reference Guide - Table of Contents \(Retail\)](#)
- [TP1748: AST 2 MRI \(OS\) suite for Mac notebook computers with the Apple T2 Security Chip](#)

Apple Diagnostics

Apple Diagnostics is a customer-facing software tool that is built into all Mac computers released in June 2013 and later.

For more information, refer to the following articles:

- [HT202731: How to use Apple Diagnostics on your Mac](#)
- [HT203747: Apple Diagnostics: Reference codes](#)

Thermal and Electrical Sensors

Reference the tables below for sensor information.

Thermal Sensor Table

SMC Name	Location	General Description (Degrees C)	Diagnosis
TALC	Logic board top side, left, near left USB-C ports	Airflow left temperature	Excessive temperature on the logic board. Check fan operation.
TARC	Logic board top side, right, near right USB-C ports	Airflow right temperature	Excessive temperature on the logic board. Check fan operation.
TB0T	Battery	Battery TS_MAX temperature	Excessive battery temperature, open/damaged BMU or logic board contacts.
TB1T	On BMU	Battery TS1 temperature	Excessive battery temperature, open/damaged BMU or logic board contacts.
TB2T	Near battery cell	Battery TS2 temperature	Excessive battery temperature, open/damaged BMU or logic board contacts.
TC0P	Logic board top side, near CPU	CPU proximity temperature	Excessive CPU temperature or logic board sensor near CPU is damaged or disconnected from SMC.
TC1C	Logic board bottom side, inside CPU	CPU IC - Digital Core 0 temperature	Excessive CPU temperature or logic board sensor near CPU is damaged or disconnected from SMC.
TC2C	Logic board bottom side, inside CPU	CPU IC - Digital Core 1 temperature	Excessive CPU temperature or logic board sensor near CPU is damaged or disconnected from SMC.
TC3C	Logic board bottom side, inside CPU	CPU IC - Digital Core 2 temperature	Excessive CPU temperature or logic board sensor near CPU is damaged or disconnected from SMC.
TC4C	Logic board bottom side, inside CPU	CPU IC - Digital Core 3 temperature	Excessive CPU temperature or logic board sensor near CPU is damaged or disconnected from SMC.
TC5C	Logic board bottom side, inside CPU	CPU IC - Digital Core 4 temperature	Excessive CPU temperature or logic board sensor near CPU is damaged or disconnected from SMC.
TC6C	Logic board bottom side, inside CPU	CPU IC - Digital Core 5 temperature	Excessive CPU temperature or logic board sensor near CPU is damaged or disconnected from SMC.
TCGC	Logic board bottom side, CPU	CPU Gfx core temperature	Excessive CPU temperature or internal CPU sensor is damaged or disconnected from SMC.
TCSA	Logic board bottom side, CPU	CPU system agent core temperature	Excessive CPU temperature or internal CPU sensor is damaged or disconnected from SMC.
TCXC	Logic board bottom side, CPU	CPU core PECI temperature	Excessive CPU temperature or internal CPU sensor is damaged or disconnected from SMC.
TG0P	Logic board top side, near GPU	GPU proximity temperature	Excessive GPU temperature or logic board sensor near GPU is damaged or disconnected from SMC.
TGVP	Logic board top side, near GPU VRAM	GPU VRAM proximity temperature	Excessive GPU VRAM temperature or logic board sensor near GPU VRAM is damaged or disconnected from SMC.
TH0A	Logic board bottom side, right, near flash storage	Flash storage NAND proximity temperature	Excessive flash storage temperature or logic board sensor near flash storage is damaged or disconnected from SMC.
TH0B	Logic board bottom side, right, near flash storage	Flash storage NAND proximity temperature	Excessive flash storage temperature or logic board sensor near flash storage is damaged or disconnected from SMC.
TH1A	Logic board bottom side, left, near flash storage	Flash storage NAND proximity temperature	Excessive flash storage temperature or logic board sensor near flash storage is damaged or disconnected from SMC.
TH1B	Logic board bottom side, left, near flash storage	Flash storage NAND proximity temperature	Excessive flash storage temperature or logic board sensor near flash storage is damaged or disconnected from SMC.
TH1H	Logic board top side, center rear edge, near right fan cutout	Fin Stack proximity right temperature	Excessive heat sink fin stack temperature or fin stack proximity sensor on logic board is damaged. Verify fan is operational for proper cooling.
TH2H	Logic board top side, center rear edge, near left fan cutout	Fin Stack proximity left temperature	Excessive heat sink fin stack temperature or fin stack proximity sensor on logic board is damaged. Verify fan is operational for proper cooling.
TM0P	Logic board bottom side, under shield, between memory ICs	Memory proximity temperature	Excessive memory area temperature or logic board sensor near memory is damaged or disconnected from SMC.
TPCD	Logic board bottom side, inside PCH	PCH IC - digital temperature	Excessive PCH temperature or internal CPU sensor is damaged or disconnected from SMC.

TS0P	Trackpad	Palm rest temperature	Excessive trackpad / palm rest area temperature or sensor is damaged or disconnected from SMC.
TS1P	Trackpad actuator	Trackpad actuator temperature	Excessive trackpad actuator temperature or sensor is damaged or disconnected from SMC.
TTLD	Logic board bottom side, left, near left USB-C ports	Thunderbolt IC temperature left	Excessive I/O temperature or logic board sensor is damaged or disconnected from SMC. Check USB-C I/O connections and fan operation.
TTRD	Logic board bottom side, right, near right USB-C ports	Thunderbolt IC temperature right	Excessive I/O temperature or logic board sensor is damaged or disconnected from SMC. Check USB-C I/O connections and fan operation.
TW0P	Logic board top side, left, mid	Wireless proximity temperature	Excessive temperature on the logic board near the wireless IC.

Electrical Sensor Table

SMC Name	Location	General Description	Units	Diagnosis
I18C	Logic board	Current: 1.8V	Amperes	Out-of-range current from the CPU's integrated voltage regulators.
IAPC	Logic board	Current: WLAN	Amperes	Out-of-range Wi-Fi current found or open signal to SMC.
IB0L	Logic board	Current: Battery Discrete	Amperes	Out-of-range battery current was found or open signal to SMC. Verify the battery connection to the logic board.
IBLR	Logic board	Current: LCD Backlight	Amperes	Out-of-range LCD backlight current found or open signal to SMC.
IC0R	Logic board	Current: CPU High (CPU GT/GTX/VCCIO/MEM)	Amperes	Out-of-range CPU current was found or open signal to SMC.
ICAC	Logic board	Current: CPU IA Core Discrete	Amperes	Out-of-range CPU current was found or open signal to SMC.
ICAM	Logic board	Current: CPU IA Core (IMON)	Amperes	Out-of-range CPU current was found or open signal to SMC.
ICMC	Logic board	Current: Camera	Amperes	Out-of-range camera current was found or open signal to SMC.
ICSC	Logic board	Current: CPU VCCSA	Amperes	Out-of-range CPU current was found or open signal to SMC.
ICTC	Logic board	Current: CPU GT	Amperes	Out-of-range CPU current was found or open signal to SMC.
ICTM	Logic board	Current: CPU GT (IMON)	Amperes	Out-of-range CPU current was found or open signal to SMC.
ID0R	Logic board	Current: USB-C/MPM (DC Input)	Amperes	Out-of-range DC-IN current. Possible defective power adapter, defective USB-C connector or open signal to SMC. Verify the correct power adapter, charge cable, and I/O connections.
IF3C	Logic board	Current: T139 3.3V	Amperes	Out-of-range current from the CPU's integrated voltage regulators.
IF5C	Logic board	Current: T139 5V	Amperes	Out-of-range current from the CPU's integrated voltage regulators.
IG0C	Logic board	Current: Ext GPU Core	Amperes	Out-of-range GPU current was found or open signal to SMC.
IG0R	Logic board	Current: Ext GPU High Side	Amperes	Out-of-range GPU current was found or open signal to SMC.
IG1C	Logic board	Current: Ext GPU Frame Buffer	Amperes	Out-of-range GPU current was found or open signal to SMC.
IG2C	Logic board	Current: Ext GPU VDDCI	Amperes	Out-of-range GPU current was found or open signal to SMC.
IG3C	Logic board	Current: Ext GPU 1.8V	Amperes	Out-of-range GPU current was found or open signal to SMC.
IG4C	Logic board	Current: Ext GPU Frame Buffer IC	Amperes	Out-of-range GPU current was found or open signal to SMC.
IHDC	Logic board	Current: SSD Picollo 3.3V	Amperes	Out-of-range flash storage current found or open signal to SMC.

IHNC	Logic board	Current: SSD NAND	Amperes	Out-of-range flash storage current found or open signal to SMC.
IIDC	Logic board	Current: T151 Touch ID	Amperes	Out-of-range Touch ID current found or open signal to SMC.
IKBC	Logic board	Current: Keyboard backlight	Amperes	Out-of-range keyboard backlight current found or open signal to SMC.
ILDC	Logic board	Current: LCD Panel	Amperes	Out-of-range LCD panel current found or open signal to SMC.
IM0C	Logic board	Current: 1.2V (CPU and Memory)	Amperes	Out-of-range current from the CPU's integrated voltage regulators.
IMCC	Logic board	Current: CPU LPDDR 1.2V	Amperes	Out-of-range current from the CPU's integrated voltage regulators.
IO3R	Logic board	Current: Other 3.3V (High)	Amperes	Out-of-range current from the CPU's integrated voltage regulators.
IO5R	Logic board	Current: Other 5V (High)	Amperes	Out-of-range current from the CPU's integrated voltage regulators.
IPBR	Logic board	Current: Battery (BMON)	Amperes	Out-of-range battery current was found or open signal to SMC. Verify the battery connection to the logic board.
IT3C	Logic board	Current: Trackpad and Keyboard 3.3V	Amperes	Out-of-range keyboard or trackpad current found or open signal to SMC.
ITAR	Logic board	Current: Trackpad Actuator (High)	Amperes	Out-of-range trackpad actuator current found or open signal to SMC.
IULC	Logic board	Current: TBT Left	Amperes	Out-of-range Thunderbolt current found or open signal to SMC.
IURC	Logic board	Current: TBT Right	Amperes	Out-of-range Thunderbolt current found or open signal to SMC.
VCAC	Logic board	Voltage: CPU IA Core	Volts	Out-of-range voltage from the CPU's integrated voltage regulators.
VCSC	Logic board	Voltage: CPU VCCSA	Volts	Out-of-range voltage from the CPU's integrated voltage regulators.
VCTC	Logic board	Voltage: CPU GT	Volts	Out-of-range voltage from the CPU's integrated voltage regulators.
VD0R	Logic board	Voltage: USB-C/MPM (DC Input)	Volts	Out-of-range DC-IN voltage. Possible defective power adapter, defective USB-C connector or open signal to SMC. Verify the correct power adapter, charge cable, and I/O connections.
VG0C	Logic board	Voltage: GPU Core	Volts	Out-of-range GPU voltage was found or open signal to SMC.
VG2C	Logic board	Voltage: Ext GPU VDDCI	Volts	Out-of-range GPU voltage was found or open signal to SMC.
VP0R	Logic board	Voltage: P-Bus	Volts	Out-of-range voltage from battery or charge circuitry found on the logic board, or open signal to SMC. Use correct power adapter and verify that the connector pins are clean and make a good electrical connection. Recharge the battery.

AST 2 MRI (OS) suite for Mac notebook computers with the Apple T2 Security Chip

This article provides information about and when to use AST 2 Mac Resource Inspector (MRI) OS for Mac notebook computers with the Apple T2 Security Chip.

Information

An MRI (OS) diagnostic suite is now available only for Mac notebook computers with the Apple T2 Security Chip, which includes these models:

- MacBook Air (Retina, 13-inch, 2018 and 2019)
- MacBook Pro (13-inch, 2019, Two Thunderbolt 3 Ports)
- MacBook Pro (13-inch, 2018 and 2019, Four Thunderbolt 3 Ports)
- MacBook Pro (15-inch, 2018 and 2019)

The Apple T2 Security Chip inside these computers controls the following components which require a known-good macOS with which to test:

- Audio
- Camera
- Flash Storage
- Power Management
- Secure element
- Touch ID
- Trackpad

MRI (OS) uses a known-good macOS to check for the presence of T2-related hardware components on these computers.

Mac notebook computers with the Apple T2 Security Chip will continue to display MRI (EFI) as an available diagnostic suite, and will have an additional selection of MRI (OS) on the AST 2 Diagnostic Console.

MRI (OS) will only be available as a choice within the Diagnostic Console for Mac notebook computers with the Apple T2 Security Chip. This suite is not available or needed for any other Mac models.

All other Mac notebook and desktop computers that are supported by AST 2 should continue to use MRI (EFI).


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diagnostics.apple.com

AST 2 Diagnostic Console Jane ▾

Diagnostic Suites

TRIAGE


**Mac Resource Inspector (EFI)**

Quick triage tool that checks for the presence of hardware components and performs a series of short tests to verify hardware functionality using EFI.

3-5 minutes >

Suggested use: during triage to provide a quick health check of hardware that can be tested using EFI.

Show Less...


**Mac Resource Inspector (OS)**

Triage tool that checks for the presence of T2-related hardware components that require an OS to test. Refer to GSX article TP1748 for more information.

6-8 minutes >

Suggested use: during triage of components that require an OS to test such as ambient light sensor, audio, bluetooth, camera, trackpad, and Touch ID.

Show Less...

**Storage (OS)**

Important: The MRI (OS) suite requires up to eight minutes to complete under normal network conditions.

When to use the MRI (OS) diagnostic suite

Mac notebook computers with the Apple T2 Security Chip may require running tests only available from within macOS.

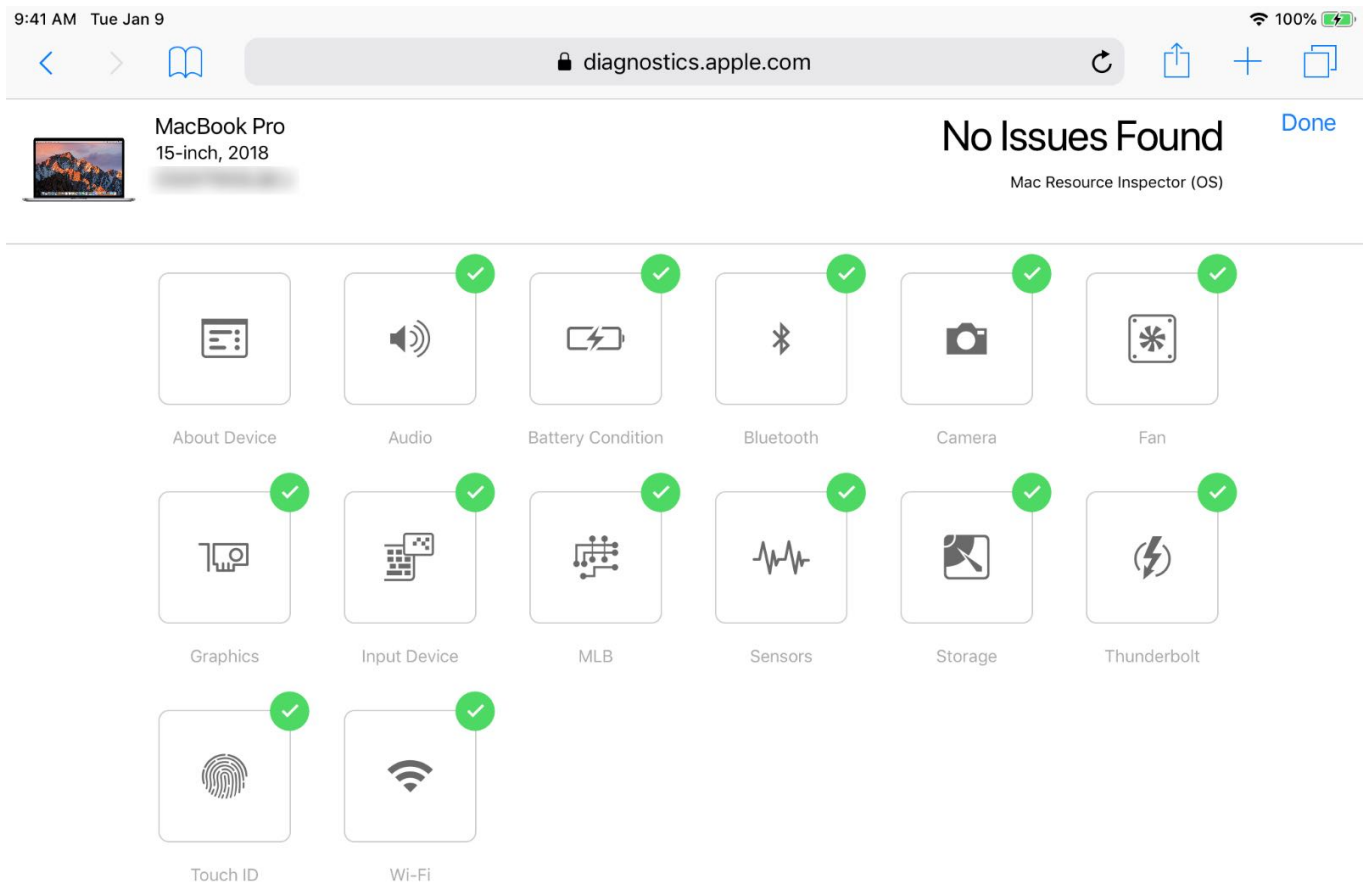
MRI (OS) is required instead of MRI (EFI) when the user reports any issue with a Mac notebook computer with the Apple T2 Security Chip that involves any T2-related components.

These tests are only available in MRI (OS):

- Ambient Light Sensor (ALS)
- Audio
- Bluetooth
- Camera
- Input device (built-in trackpad)
- Touch ID

The MRI (OS) diagnostic suite also includes many of the same tests as the MRI (EFI) diagnostic suite, so in most cases you would not need to run both suites on Mac notebook computers with the Apple T2 Security Chip.

For example, the Battery, Fan, and Sensor tests exist in both MRI (EFI) and MRI (OS) because the other tests depend on these critical components. Graphics, Logic Board, Storage, Thunderbolt, and Wi-Fi tests take just a few seconds to run, so these are included in both MRI (EFI) and MRI (OS). These EFI and OS tests are functionally the same, so you do not need to run these tests in both EFI and OS.



Note: The screen shot above shows the available tests within MRI (OS) for MacBook Pro (15-inch, 2018); available tests for other models may vary.

During triage and before repair: MRI (OS) can be used to verify the presence of T2-related hardware components inside a Mac notebook computer with the Apple T2 Security Chip.

Run MRI (OS) to detect the presence of T2-related components for the following parts:

- MacBook Air (Retina, 13-inch, 2018):
 - Logic board
 - Touch ID board
- MacBook Air (Retina, 13-inch, 2019)
 - Display assembly
 - Logic board
 - Touch ID board
- MacBook Pro (13-inch, 2019, Two Thunderbolt 3 Ports), MacBook Pro (13-inch, 2018 and 2019, Four Thunderbolt 3 Ports), and MacBook Pro (15-inch, 2018 and 2019):
 - Display assembly
 - Logic board
 - Top case assembly
 - Touch ID board

After reassembly: For the parts listed above, you must also run the System Configuration repair completion suite. Refer to [System Configuration for Macs with the Apple T2 Security Chip](#) (TP1657).

After repair: For all hardware repairs, run Full System Diagnostic (OS) and Full System Diagnostic (EFI) suites to complete system testing of all hardware components after repair. The Full System Diagnostic suites also include all relevant tests within MRI (OS), so you do not need to run MRI (OS) again.

When to use the MRI (EFI) diagnostic suite

Some tests are only available in MRI (EFI) and are not available in MRI (OS).

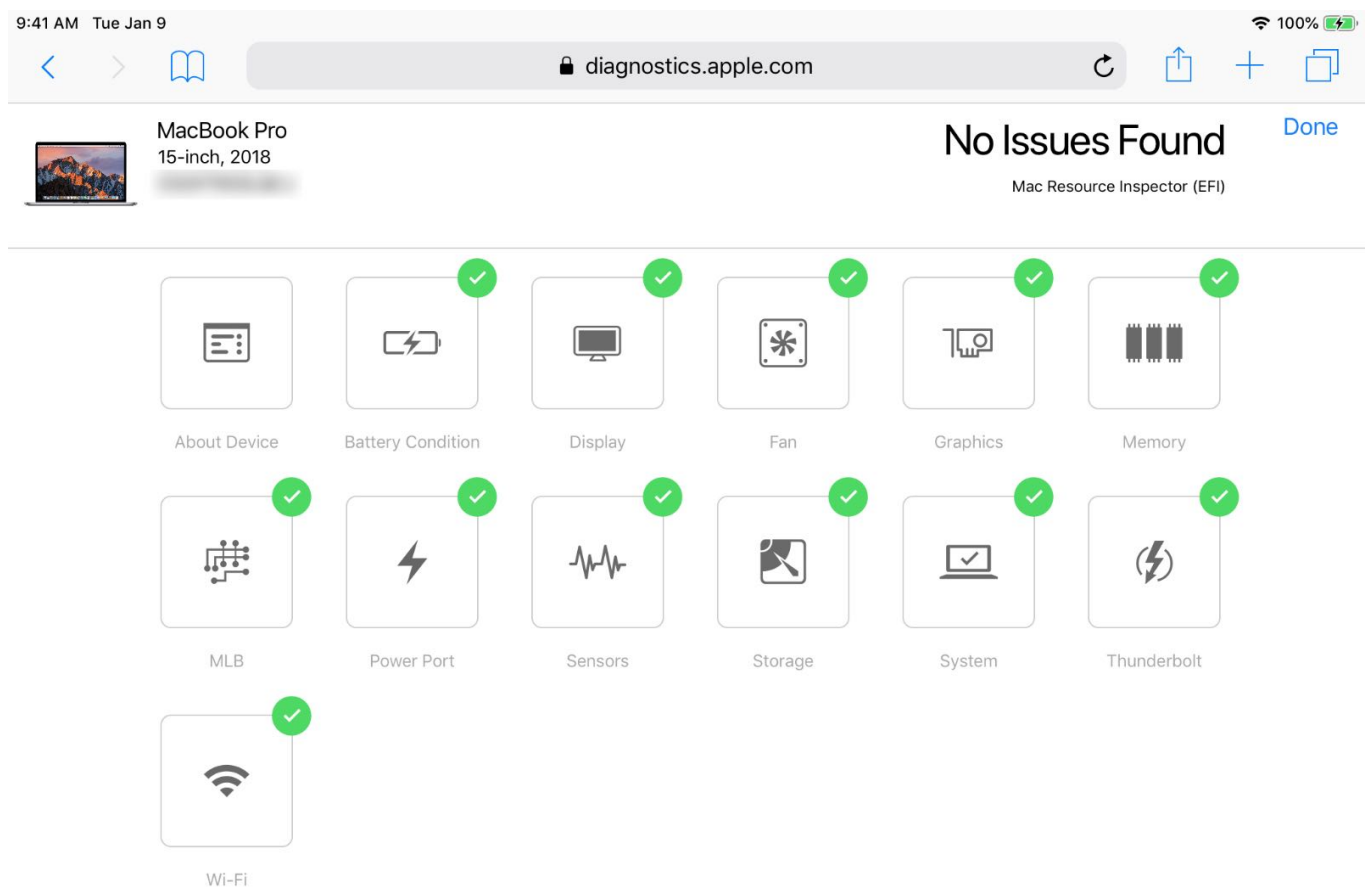
The following tests are only available in MRI (EFI):

- Display
- Memory
- Power Port
- System

The following tests are present in both MRI (EFI) and MRI (OS):

- About device
- Battery condition
- Fan
- Graphics
- MLB
- Sensors
- Storage
- Thunderbolt
- Wi-Fi

These tests are functionally the same, so you only need to run these tests from either MRI (EFI) or MRI (OS). You do not need to run these tests from both environments.



Note: The screen shot above shows the available tests within MRI (EFI) for MacBook Pro (15-inch, 2018); available tests for other models may vary.

MRI (EFI) is recommended instead of MRI (OS) in the following circumstances:

- When the user reports any issue that involves testing memory, the display, the power port, or the presence of the recovery partition.
- When the user reports any issue with a Mac desktop or notebook computer other than a Mac notebook computer with the Apple T2 Security Chip.

If AST 2 MRI (OS) is not listed as an available diagnostic suite to run in your AST 2 Diagnostic Console, check the following:

- Verify that the UUT is a Mac notebook computer with the Apple T2 Security Chip.
- The AST 2 Diagnostic Console will only display applicable diagnostic suites for a UUT. For information about supported products and tests, refer to [TP1279: AST 2: Supported Products and Tests](#).

If AST 2 MRI (OS) is an available diagnostic suite to run on your AST 2 Diagnostic Console, but the UUT is having trouble connecting to AST 2, check the following:

- Verify that your service location's AST 2 Diagnostic Server Gateway Mac is running. For more information, refer to [TP953: AST Reference Guide: Installing macOS Server 10.12 through macOS Server 10.13 on the Diagnostic Gateway Mac](#) and [TP1722: AST Reference Guide - Diagnostic Server Installation, Configuration, and Troubleshooting - macOS 10.14 and Later](#).
- Verify that your service location's AST 2 Diagnostic Server Gateway Mac has the latest AST 2 diagnostic OS images and tools installed and configured. For more information, refer to [OP476: Latest Apple Service Toolkit download links and documentation](#).
- Verify that the UUT is connected to the same LAN as your service location's AST 2 Diagnostic Gateway Server Mac. For more information, refer to [TP921: AST 2 Network Theory of Operation](#).

Temperature Concerns

The normal operating temperature of Mac notebook computers is well within national and international safety standards. Nevertheless, a user may be concerned that their computer is warm. To prevent an unnecessary repair, compare the user's computer to a similar running model with a similar load if available.

For more information, refer to the following articles:

- [HT201640: Keep your Mac notebook within acceptable operating temperatures](#)
- [HT203184: See how apps affect Mac performance, battery runtime, temperature, and fan activity](#)
- [HT202179: About fans and fan noise in your Apple product](#)

LCD Pixel Anomalies

When displaying a single color over the screen area, the liquid crystal display (LCD) might show one or more pixels that are not properly lit.

LCD technology uses rows and columns of addressable points (pixels) that render text and images on the screen. Each pixel has three separate subpixels (red, green, and blue) that allow an image to render in full color. Each subpixel has a corresponding transistor responsible for turning the subpixel on and off.

Depending on the display size, there can be thousands or millions of subpixels on an LCD. For example, the LCD used in iMac (27-inch, Late 2013) has a display resolution of 2560 by 1440, which means there are 3.7 million pixels. Each pixel is made up of a red, a green, and a blue subpixel, resulting in over 11 million individual picture elements on the 27-inch display. Occasionally, a transistor may not work perfectly, resulting in the affected subpixel remaining off (dark) or on (bright). With the millions of subpixels on a display, it is possible to have a low number of such transistors on an LCD. In some cases, a small piece of dust or other foreign material may appear to be a pixel anomaly. Apple strives to use the highest-quality LCD displays in its products, but pixel anomalies can occur in a small percentage of them.

In some cases, pixel anomalies are caused by a piece of foreign material that is trapped inside the display or on the surface of the display or glass panel. Foreign material is typically irregular in shape and is usually most noticeable when viewed against a white background.

- For any computer, foreign material on the surface of the display or glass panel can easily be removed using a lint-free cloth.
- For any computer, foreign material trapped inside the display can only be resolved by replacing the entire display assembly.

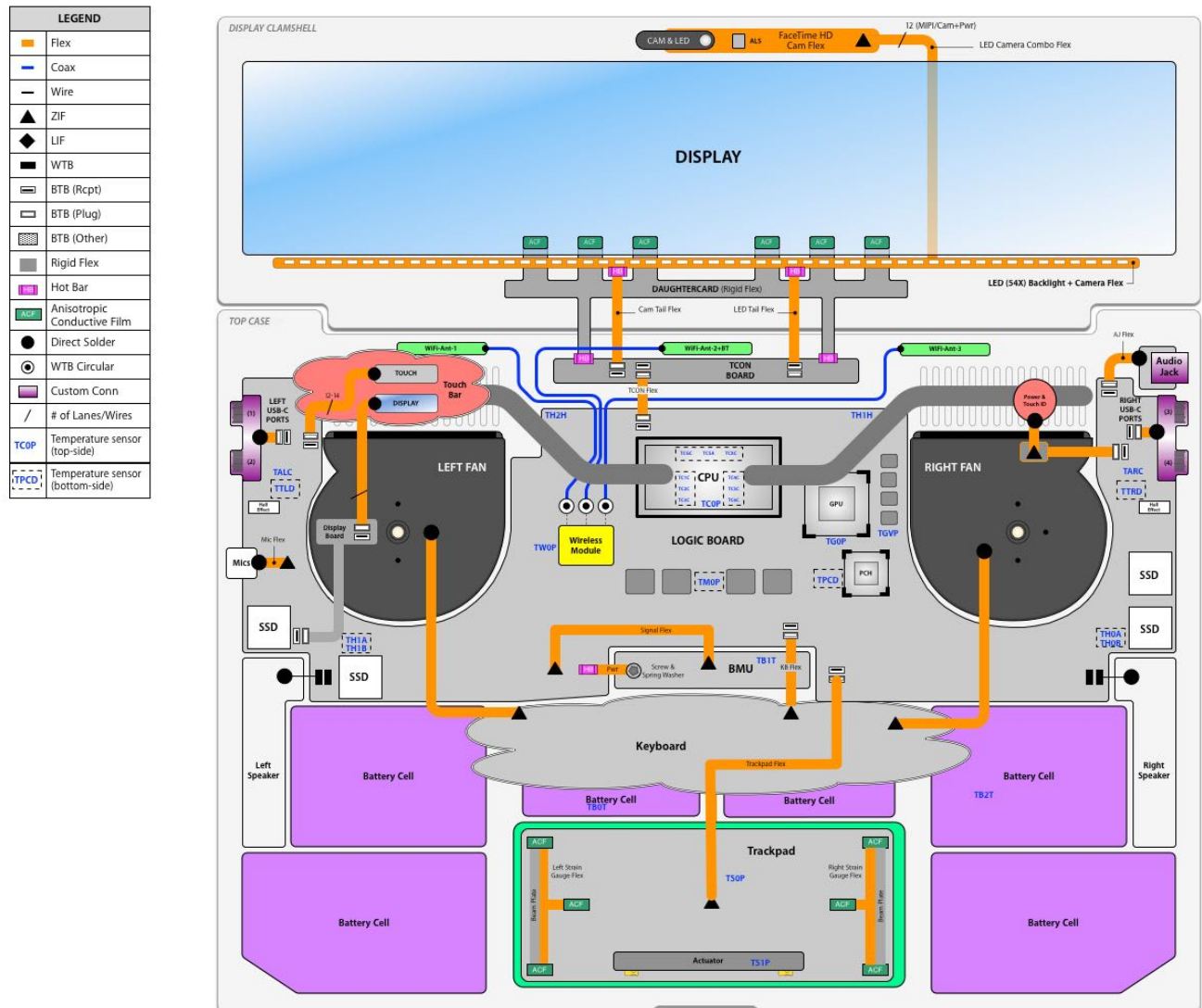
To determine if the display has an acceptable number of pixel anomalies, see the appropriate article:

- [HT202025: About LCD display pixel anomalies for Apple products released in 2010 and later](#)
- [HT201613: About LCD display pixel anomalies for Apple products released before 2010](#)

Interconnect Diagram

Interconnect Diagram for MacBook Pro (15-inch, 2018 and 2019)

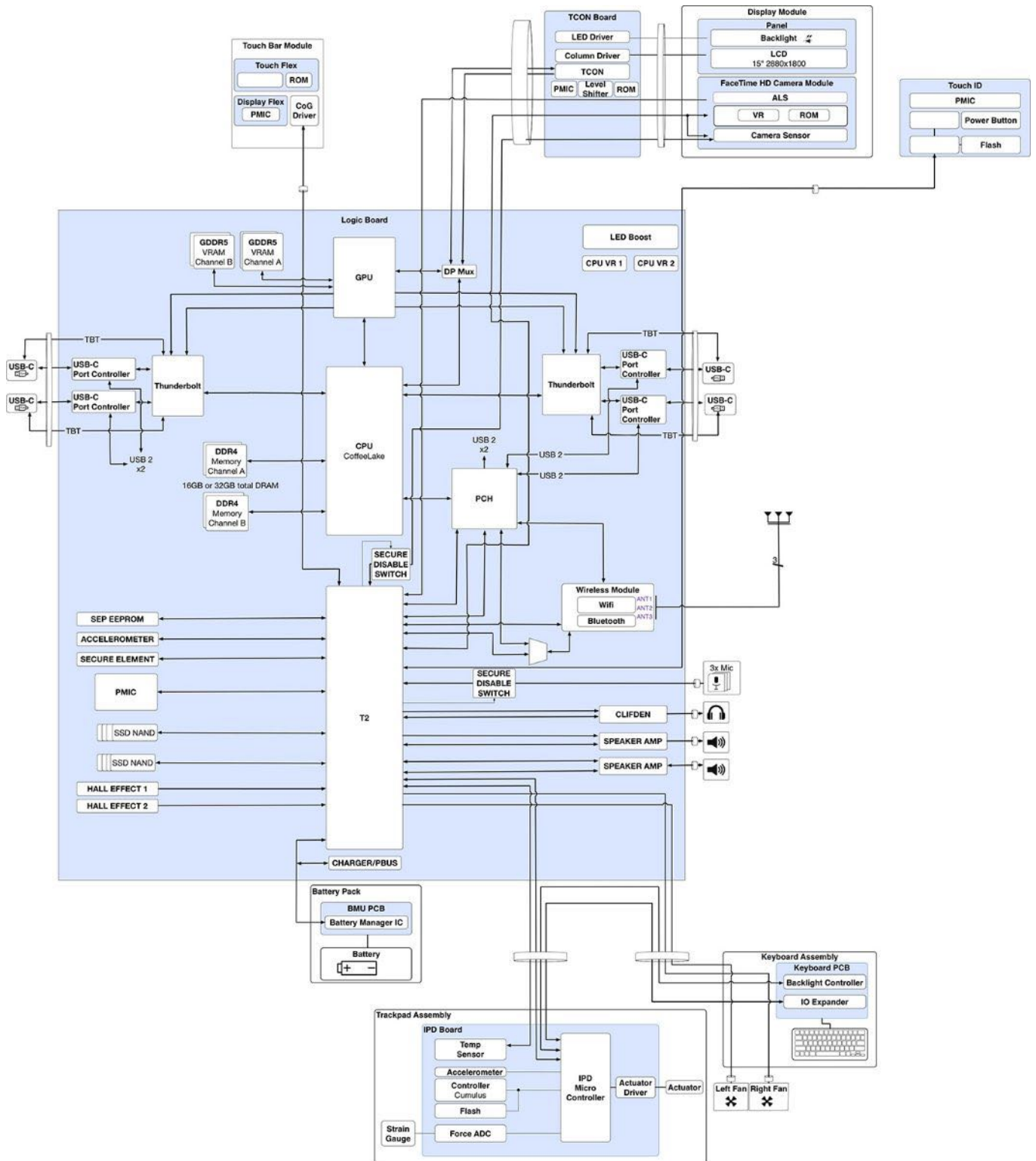
Refer to this diagram to see how modules are interconnected.



Block Diagram

Block Diagram for MacBook Pro (15-inch, 2018 and 2019)

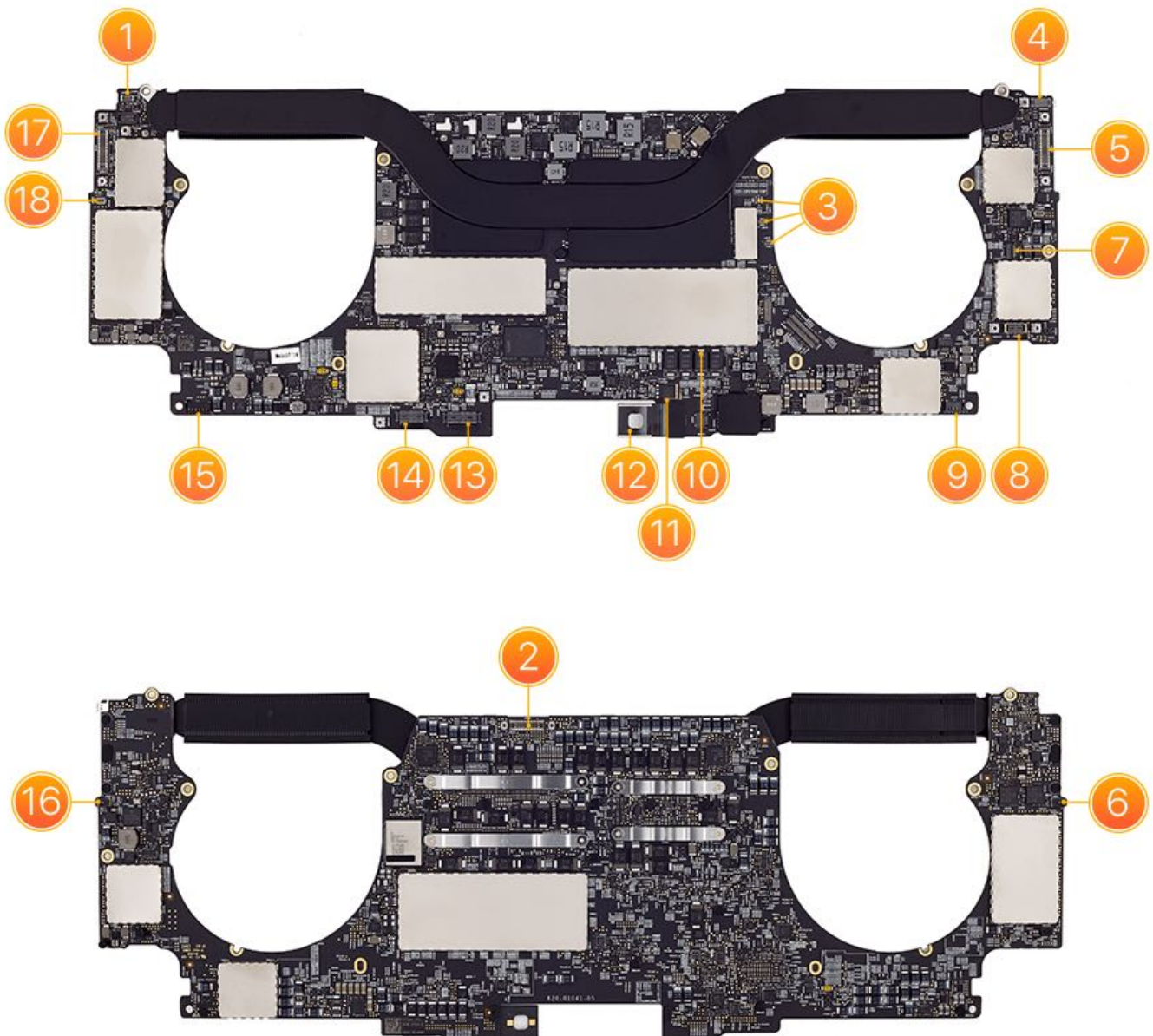
Refer to this diagram to see how modules are interrelated.



Functional Overview

Functional Overview for MacBook Pro (15-inch, 2018 and 2019)

Although this diagram pictures a MacBook Pro (15-inch, 2018) logic board, refer to this diagram for symptoms related to both models. The functional areas are in the same locations regardless of the configuration.



1 = Touch ID board flex

- Will not turn on from power button
- Will not authenticate using Touch ID

2 = Embedded DisplayPort (eDP) cable (also carries FaceTime HD camera & ambient light sensor signals)

- No video, blurred, distorted, or monochrome video on display
- No display backlight
- Display does not dim in low light conditions
- Keyboard backlight cannot be enabled
- Camera does not function

3 = Wi-Fi + Bluetooth antenna connectors

- No/poor Wi-Fi reception
- Drops Wi-Fi connection
- Does not pair with Bluetooth devices
- Drops Bluetooth connection

4 = Touch Bar flex cable

- No touch response on Touch Bar

5 = USB-C ports (left) identical to 17 = USB-C ports (right)

- No power
- No power LED
- No battery charge
- Power adapter issues
- USB connectivity issues
- USB power issues
- No video to external display
- No audio to external display speakers
- Thunderbolt device not found
- Thunderbolt controller not recognized
- Thunderbolt driver issue
- Thunderbolt power issues

6 = Left Hall effect sleep sensor

- No sleep when display closed
- No wake when display opened
- No video to internal display, but video to external display if one is connected (sensor stuck)

7= Tri-Mic flex cable

- No microphone audio input (with Internal Microphone selected in Sound Input Preferences)
- Distorted microphone audio input

8 = Touch Bar Display flex cable

- No video, blurred, distorted, or monochrome video on Touch Bar display

9 = Left speaker

- No audio from left speaker
- Distorted audio from left speaker

10 = Onboard Memory (soldered on bottom of logic board)

- Freeze or kernel panic
- Horizontal video lines

11 = Battery (BMU signal flex)

- No power
- Not charging (verify with correct model of power adapter)
- Battery icon in menu bar contains an X

12 = Battery (BMU power flex and BMU interconnect screw)

- No power
- Not charging (verify with correct model of power adapter)
- Battery icon in menu bar contains an X

13 = Trackpad flex cable (also carries keyboard backlight controls)

- No Multi-Touch or cursor movement from built-in trackpad
- No click action from built-in trackpad
- No keyboard backlight

14 = Keyboard flex cable (also carries keyboard backlight controls and fan power)

- Nonresponsive keys
- No keyboard backlight
- Fans not running
- Intermittent shutdown

15 = Right speaker

- No audio from right speaker

- Distorted audio from right speaker

16 = Right Hall effect sleep sensor

- No sleep when display closed
- No wake when display opened
- No video to internal display, but video to external display if one is connected (sensor stuck)

17 = USB-C ports (right) identical to 5 = USB-C ports (left)

18 = Audio board flex cable

- No external audio input
- No headphone audio output
- No headset controls or mic input

Bluetooth Issues

Unlikely causes:

Bottom case, Display assembly, AC Wall adapter (duckhead), eDP flex cable, Fan, Keyboard flex cable, I/O board, Audio board, Power adapter, Power cord, Top case assembly, USB-C charging cable.

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">Bluetooth service not availableCannot turn Bluetooth onBluetooth can be turned on, but the computer is unable to pair with a known-good Bluetooth deviceIntermittent loss of communication with paired Bluetooth deviceData transfer over Bluetooth times out or is too slow <p>Note: Inform the user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover and disconnected the battery.</p> <ol style="list-style-type: none">In System Preferences > Bluetooth, check that Bluetooth is on.Attempt to pair the computer with a known-good Bluetooth keyboard, mouse, or trackpad.Reset the Bluetooth device or delete the pairing (if applicable).Refer to HT201260: Find out which macOS your Mac is using to check that the system build is correct for this computer model.Check for and apply the latest software and firmware updates.If the customer is using a USB 3 device, review HT201163: Using USB devices with your Mac to identify possible interference with Wi-Fi and Bluetooth communications if the device is positioned near their antennas.If the user's computer pairs Bluetooth normally at your service location, research potential sources of interference in the user's environment, such as microwave ovens or cordless phones in the 2.4/5GHz range. Refer to HT201542: Resolve Wi-Fi and Bluetooth issues caused by wireless interference.Reset the NVRAM using the procedure for this computer in HT204063: Reset NVRAM or PRAM on your Mac.Reset the SMC using the procedure listed for this computer in HT201295: How to reset the System Management Controller (SMC) on your Mac. Do not hold in the power button when turning on the computer. You could inadvertently put the computer into DFU mode if you do.

Deep Dive

	Check	Result	Action	Code	Commodity
1.	<p>Check Mac Resource Inspector (MRI) test results or System Information > Hardware > USB device tree to verify that the Bluetooth controller is listed.</p> <p>Is Bluetooth hardware detected?</p>	Yes	Go to step 2.	\$(nodeText.yesSymptomCode)	
		No	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M36	MLB
2.	<p>Open System Preferences > Bluetooth. Remove all paired devices. Pair the computer with a known-good Bluetooth device.</p> <p>Does the computer pair with a known-good Bluetooth device?</p>	Yes	Go to the “External Apple Bluetooth Peripherals” troubleshooting flow.	\$(nodeText.yesSymptomCode)	
		No	Go to step 3.	\$(nodeText.noSymptomCode)	
3.	<p>Follow steps in HT208198: About Startup Security Utility to enable starting up from an external storage device on the user’s computer.</p> <p>Start up the computer to a known-good external macOS startup volume.</p> <p>Try to connect to the known-good Bluetooth device. Compare Bluetooth performance and reliability to a known-good computer of similar type and Bluetooth specification.</p> <p>Does the issue persist with known-good macOS?</p>	Yes	Go to step 4.	\$(nodeText.yesSymptomCode)	
		No	<p>Reinstall macOS on the user’s computer.</p> <p>Check for and apply the latest software and firmware updates.</p> <p>Verify that the issue is resolved.</p>	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
4.	<p>Locate the wireless antenna connectors on the logic board. Unplug them and inspect the antenna cables and their connectors for any signs of pinched wires or connector damage.</p> <p>Do the antenna cables or connectors show signs of damage?</p>	Yes	<p>Replace the vent/antenna module.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	X03	OTHER ELECTRIC
		No	Go to step 5.	\$(nodeText.noSymptomCode)	
5.	<p>With the antenna cables unplugged, inspect the wireless antenna cable connectors on the logic board for housing or pin damage.</p> <p>Do the antenna connectors on the logic board show signs of damage?</p>	Yes	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M24	MLB
		No	Go to step 6.	\$(nodeText.noSymptomCode)	
6.	<p>Reseat the antenna cable connectors to the logic board, then retry pairing with a known-good Bluetooth device.</p> <p>Is the computer able to pair with a known-good Bluetooth device?</p>	Yes	The issue was resolved by reseating the Bluetooth antenna to the logic board. Verify that the issue is resolved.	\$(nodeText.yesSymptomCode)	
		No	Go to step 7.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
7.	<p>Troubleshooting this issue completely requires the following known-good parts:</p> <ul style="list-style-type: none"> Logic board Vent/antenna module <p>Do you have immediate access to each of these known-good parts?</p>	Yes	Go to step 8.	\${nodeText.yesSymptomCode}	
		No	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M36	MLB
8.	<p>Substitute known-good vent/antenna module, then retry pairing with a known-good Bluetooth device.</p> <p>Is the computer able to pair with a known-good Bluetooth device?</p>	Yes	<p>Replace the vent/antenna module.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	X03	OTHER ELECTRIC
		No	Go to step 9.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
9.	Substitute a known-good logic board. Retry pairing with a known-good Bluetooth device. Is the computer able to pair with a known-good Bluetooth device?	Yes	Replace the logic board and Touch ID board. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair. Verify that the issue is resolved.	M36	MLB
		No	ESCALATION REQUIRED. Contact CSS for additional support or a multipart repair.	X99	
10.	Pair with a known-good Bluetooth device and verify that the connection is sustained for several minutes. Run AST 2 Full System diagnostic suites (EFI & OS), if available, to ensure no other issues remain. Is the issue resolved?	Yes	The issue is resolved.	\${nodeText.yesSymptomCode}	
		No	ESCALATION REQUIRED. Contact CSS for additional support or a multipart repair.	X99	

Wi-Fi Issues

Unlikely causes:

Bottom case, Display assembly, AC Wall adapter (duckhead), eDP flex cable, Fan, Keyboard flex cable, I/O board, Audio board, Power adapter, Power cord, Top case assembly, USB-C charging cable.

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">• Wi-Fi service not available• Cannot turn Wi-Fi on• Wi-Fi can be turned on, but cannot connect to known-good Wi-Fi network• Intermittent loss of Wi-Fi communication• Poor Wi-Fi signal <p>Note: Inform the user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover and disconnected the battery.</p> <ol style="list-style-type: none">1. In System Preferences > Network, check that Wi-Fi is on.2. Attempt to connect the computer to a known-good Wi-Fi network.3. Create a new network location in System Preferences.4. Refer to HT201260: Find out which macOS your Mac is using to check that the system build is correct for this computer model. Using Ethernet network interface, connect to the Internet, then check for and apply latest software and firmware updates.5. If the customer is using a USB 3 device, review HT201163: Using USB devices with your Mac to identify possible interference with Wi-Fi and Bluetooth communications if the device is positioned near their antennas.6. If the user's computer connects normally to Wi-Fi at your service location, research potential sources of interference in the user's environment, such as microwave ovens or cordless phones in the 2.4/5GHz range. Refer to HT201542: Resolving Wi-Fi and Bluetooth issues caused by wireless interference.7. Refer to HT202663: Check for Wi-Fi issues using your Mac to familiarize yourself with the macOS Wireless Diagnostic utility.8. Reset the NVRAM using the procedure for this computer in HT204063: Reset NVRAM or PRAM on your Mac.9. Reset the SMC using the procedure listed for this computer in HT201295: How to reset the System Management Controller (SMC) on your Mac. Do not hold in the power button when turning on the computer. You could inadvertently put the computer into DFU mode if you do.

Deep Dive

	Check	Result	Action	Code	Commodity
1.	<p>Check Mac Resource Inspector (MRI) test results or System Information > Network > Wi-Fi to verify that the wireless module is listed.</p> <p>Is Wi-Fi hardware detected?</p>	Yes	Go to step 2.	`\${nodeText.yesSymptomCode}`	
		No	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M35	MLB
2.	<p>Run Wireless Diagnostics by holding down the Option key, clicking the wireless icon in the menu bar, and then choosing Open Wireless Diagnostics.</p> <p>Wireless Diagnostics can also be found at: /System/Library/CoreServices/Applications/WirelessDiagnostics.app</p> <p>Does the computer complete Wireless Diagnostics with no issues?</p>	Yes	Go to step 3.	`\${nodeText.yesSymptomCode}`	
		No	Go to step 4.	`\${nodeText.noSymptomCode}`	
3.	<p>Connect to a known-good wireless network and open Wireless Diagnostics > Window > Performance. Review the quality graph to evaluate the signal quality of the wireless connection. Verify that the signal is good or excellent, and that the transmission rate (Tx Rate) is comparable to another known-good computer of similar type and Wi-Fi specification. Where available, switch between 2.4GHz and 5GHz networks to verify that the signal quality is comparable to a known-good computer.</p> <p>Using a network with a high transmission rate, download a large file from a known-good website or file server. Compare network performance to another known-good computer of similar type and Wi-Fi specification. Verify throughput using Activity Monitor > Network.</p> <p>Are the performance and throughput comparable between the user's computer and a known-good computer?</p>	Yes	Wi-Fi performance is within specification. Verify that the issue is resolved.	`\${nodeText.yesSymptomCode}`	
		No	Go to step 4.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
4.	Use one of the following two methods to start up the computer to a known-good macOS.	Yes	Go to step 5.	`\${nodeText.yesSymptomCode}`	
	<p>Start up the computer to macOS Recovery. See HT201314: About macOS Recovery.</p> <p>Follow steps in HT208198: About Startup Security Utility to enable starting up from an external storage device on the user's computer. Then start up the computer to a known-good external macOS startup volume.</p> <p>Attempt to reproduce the Wi-Fi performance or connection issue.</p> <p>Does the issue persist with known-good macOS?</p>	No	<p>Reinstall macOS on the user's computer.</p> <p>Check for and apply the latest software and firmware updates.</p> <p>Verify that the issue is resolved.</p>	`\${nodeText.noSymptomCode}`	
5.	<p>Locate the wireless antenna connectors on the logic board. Unplug them and inspect the antenna cables and their connectors for any signs of pinched wires or connector damage.</p> <p>Do the antenna cables or connectors show signs of damage?</p>	Yes	<p>Replace the vent/antenna module.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	X03	OTHER ELECTRIC
		No	Go to step 6.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
6.	<p>With the antenna cables unplugged, inspect the wireless antenna cable connectors on the logic board for housing or pin damage.</p> <p>Do the antenna connectors on the logic board show signs of damage?</p>	Yes	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M24	MLB
		No	Go to step 7.	`\${nodeText.noSymptomCode}`	
7.	<p>Reseat the antenna cable connectors to the logic board, then connect to a known-good Wi-Fi network.</p> <p>Is the computer able to connect to a known-good Wi-Fi network?</p>	Yes	The issue was resolved by reseating the wireless antenna connectors to the logic board. Verify that the issue is resolved.	`\${nodeText.yesSymptomCode}`	
		No	Go to step 8.	`\${nodeText.noSymptomCode}`	
8.	<p>Troubleshooting this issue completely requires a known-good vent/antenna module.</p> <p>Do you have immediate access to a known-good vent/antenna module?</p>	Yes	Go to step 9.	`\${nodeText.yesSymptomCode}`	
		No	Go to step 10.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
9.	Substitute known-good vent/antenna module, then connect to a known-good Wi-Fi network. Is the computer able to connect to a known-good Wi-Fi network?	Yes	Replace the vent/antenna module. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair. Verify that the issue is resolved.	X03	OTHER ELECTRIC
		No	Go to step 10.	`\${nodeText.noSymptomCode}`	
10.	Determine if the following symptom was observed on the user's computer: <ul style="list-style-type: none"> No Wi-Fi signal. Does this symptom accurately describe the user's issue?	Yes	Replace the logic board and Touch ID board. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair. Verify that the issue is resolved.	M40	MLB
		No	Go to step 11.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
11.	<p>Determine if the following symptom was observed on the user's computer:</p> <ul style="list-style-type: none"> Cannot connect to a known-good Wi-Fi network. <p>Does this symptom accurately describe the user's issue?</p>	Yes	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M41	MLB
		No	Go to step 12.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
12.	<p>Determine if the following symptom was observed on the user's computer:</p> <ul style="list-style-type: none"> Onboard Wi-Fi Performance issue. <p>Does this symptom accurately describe the user's issue?</p>	Yes	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M42	MLB
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	<p> <code> \${nodeText.noSymptomCode} </code> </p>	
13.	<p>Connect to a known-good wireless network and retest data throughput, checking for adequate transfer speeds.</p> <p>Verify that wireless connection is sustained for several minutes.</p> <p>Run AST 2 Full System Diagnostic (EFI & OS), if available, to ensure no other issues remain.</p> <p>Verify that the issue is resolved.</p> <p>Is issue resolved?</p>	Yes	The issue is resolved.	<p> <code> \${nodeText.yesSymptomCode} </code> </p>	
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	

Backlight Issue or No Backlight

Unlikely causes:

Bottom case, duckhead, eDP flex cable, fans, keyboard flex cable, I/O boards, audio board, power adapter, top case assembly, USB-C charging cable, vent/antenna module.

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">• Display not illuminated• Display backlight fails after warm-up• Display backlight fails at certain brightness settings• Unit appears to turn on and operate, but no image is seen on the display <p>Note: Inform the user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw.</p> <p>Note: This procedure is intended for display issues with the main display only. If the user has display issues with the Touch Bar display, return to the list of symptoms and choose “Touch Bar Issues” from the troubleshooting menu.</p> <ol style="list-style-type: none">1. Check for and apply the latest software and firmware updates.2. Refer to HT201260: How to find the macOS version number on your Mac to check that the system build is correct for this computer model.3. Reset the NVRAM using the procedure for this computer in HT204063: How to Reset NVRAM or PRAM on your Mac.4. Reset the SMC using the procedure for this computer in HT201295: How to reset the System Management Controller (SMC) on your Mac.5. Adjust the brightness to the maximum setting.6. Put the display to sleep by pressing Shift-Control-Power. Wait five seconds, then wake the display by pressing any key.

Deep Dive

	Check	Result	Action	Code	Commodity
1.	Connect an external display with USB-C Digital AV Multiport Adapter or USB-C VGA Multiport Adapter. Check to see if the external monitor displays video at startup. Does the external display show a video signal?	Yes	Go to step 2.	\$(nodeText.yesSymptomCode)	
		No	Go to the “Power But Blank/No Video” troubleshooting flow.	\$(nodeText.noSymptomCode)	
2.	Check Mac Resource Inspector (MRI) results to verify that the LCD is detected. If Apple Service Toolkit (AST) 2 is not available, go to System Information > Graphics/Displays to verify that the color LCD is recognized. Does MRI or System Information detect the internal LCD panel?	Yes	Go to step 3.	\$(nodeText.yesSymptomCode)	
		No	Go to the “Power But Blank/No Video” troubleshooting flow.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
3.	Start up the computer normally. Clean the display glass of all fingerprints and dirt, then shine a bright light on the display to illuminate it.	Yes	Go to step 4.	\$(nodeText.yesSymptomCode}	
	The Apple menu icon in the menu bar should always be visible and provide a reliable, high-contrast, and identifiable icon.	No	Go to the “Power But Blank/No Video” troubleshooting flow.	\$(nodeText.noSymptomCode}	
	Does the display show a legible image despite not being backlit?				
4.	Inspect eDP flex cable while reseating eDP cable connector on logic board and display assembly.	Yes	Issue resolved. Verify resolution.	\$(nodeText.yesSymptomCode}	
	Even if connection looks good, cable reseat might restore display backlight.				
4.	Make sure any electromagnetic interference (EMI) gasket on connector is correctly placed to avoid shorting out data signals and disabling backlight.	No	Go to step 5.	\$(nodeText.noSymptomCode}	
	Is backlight functionality restored?				
5.	Disconnect and inspect the eDP flex cable for damage. Pay attention to the body of the cable, looking for pinching or crimping; also check both ends of the cable, examining where the contacts are laminated to the insulator at the ends.	Yes	Go to step 6.	\$(nodeText.yesSymptomCode}	
		No	Go to step 7.	\$(nodeText.noSymptomCode}	
	Did you find cable or connector damage?				

	Check	Result	Action	Code	Commodity
6.	<p>Determine whether the damage is located on the eDP flex cable, the logic board, the display assembly, or multiple parts.</p> <p>Is the damage limited to the eDP flex cable?</p>	Yes	<p>Replace eDP flex cable.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	X03	INTERNAL CABLE
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X03	
7.	<p>Locate display backlight fuse on logic board. Refer to OP478: Backlight fuse location images.</p> <p>Test fuse continuity using a digital multimeter. For instruction on using a multimeter, see HT3250: Using a digital multimeter.</p> <p>Note: A good fuse will have a measurement of zero to one ohm. If the fuse measures higher than one (>1) ohm, it is burned out. This may indicate a display backlight short. If so, this short could burn out a second logic board. Both the display and logic board should be replaced simultaneously to prevent further part damage.</p> <p>Is display backlight fuse burned out?</p>	Yes	Go to step 8.	\$(nodeText.yesSymptomCode)	
		No	Go to step 11.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
8.	<p>Troubleshooting this issue completely requires the following known-good parts:</p> <ul style="list-style-type: none"> display assembly logic board <p>Do you have immediate access to both known-good parts?</p>	Yes	Go to step 9.	\$(nodeText.yesSymptomCode)	
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	M25	
9.	<p>Substitute a known-good display assembly and known-good logic board, and retest backlight function.</p> <p>Is backlight functionality restored?</p>	Yes	Go to step 10.	\$(nodeText.yesSymptomCode)	
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	M25	
10.	<p>Reinstall the user's display assembly.</p> <p>Continue to use a known-good logic board and retest backlight function.</p> <p>Is backlight functionality restored?</p>	Yes	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M25	MLB
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	M25	

	Check	Result	Action	Code	Commodity
11.	<p>To continue troubleshooting this issue, a known-good display assembly is required.</p> <p>Do you have immediate access to a known-good display assembly?</p>	Yes	Go to step 12.	\${nodeText.yesSymptomCode}	
		No	<p>Replace the display assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	L09	LCD

	Check	Result	Action	Code	Commodity
12.	Substitute a known-good display assembly and retest backlight function.	Yes	<p>Replace the display assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	L09	LCD
	Is backlight functionality restored?	No	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M25	MLB
13.	Restart the computer and verify that the internal display, backlight, camera, and ambient light sensor are functioning normally.	Yes	The issue is resolved.	\$(nodeText.yesSymptomCode)	
	<p>Run MRI and any other applicable diagnostics to verify that no additional issues remain.</p> <p>Are all issues resolved?</p>	No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	

Corrupted or Distorted Video

Unlikely causes:

Bottom case, duckhead, fans, keyboard flex cable, I/O boards, audio board, power adapter, top case assembly, USB-C charging cable, vent/antenna module.

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">• Distorted or illegible image on the display• Inconsistent clarity of image• Image flicker• Video “noise”• Cannot change resolution on display <p>Note: Inform the user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw.</p> <p>Note: This procedure is intended for display issues with the main display only. If the user has display issues with the Touch Bar display, return to the list of symptoms and choose “Touch Bar Issues” from the troubleshooting menu.</p> <ol style="list-style-type: none">1. Refer to HT201260: Find out which macOS your Mac is using to check that the system build is correct for this computer model. Incorrect video graphic drivers will not work properly. Check for and apply the latest software and firmware updates.2. Reset the NVRAM using the procedure for this computer in HT204063: Reset NVRAM or PRAM on your Mac.3. Reset the SMC using the procedure for this computer in HT201295: How to reset the System Management Controller (SMC) on your Mac.4. Start up the computer to macOS Recovery. See HT201314: About macOS Recovery.

Deep Dive

	Check	Result	Action	Code	Commodity
1.	Follow steps in Restore Apple T2 firmware on 2018 MacBook Pro to restore the T2 firmware on the user’s computer.	Yes	Go to step 2.	\$(nodeText.yesSymptomCode)	
	Restart the computer and verify that it completely starts up to macOS. Retest the display. Does the issue persist after restoring T2 firmware?	No	The issue was resolved by restoring T2 firmware.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
2.	<p>Connect a known-good external display, keyboard, and mouse with a known-good USB-C VGA or Digital AV Multiport Adapter. Turn on the computer and close the display assembly. Use an external keyboard or mouse to ensure that the unit stays awake and check to see if the external display correctly displays video.</p> <p>Does the external display also exhibit distorted video?</p>	Yes	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M31	MLB
		No	Go to step 3.	\$(nodeText.noSymptomCode)	
3.	<p>If issue seems to be flickering video, use a bright light to determine if the backlight alone is flickering.</p> <p>Try adjusting the brightness to determine whether the issue is linked solely to the display backlight.</p> <p>Is the symptom visible regardless of the backlight state?</p>	Yes	Go to step 4.	\$(nodeText.yesSymptomCode)	
		No	Go to the “Backlight Issue / No Backlight” troubleshooting flow.	\$(nodeText.noSymptomCode)	
4.	<p>While observing the issue, move the display assembly back and forth.</p> <p>Does the symptom change with display movement?</p>	Yes	Go to step 5.	\$(nodeText.yesSymptomCode)	
		No	Go to step 14.	\$(nodeText.noSymptomCode)	
5.	<p>Disconnect and inspect the eDP flex cable for damage. Pay attention to the body of the cable, looking for pinching or crimping; also check both ends of the cable, examining where the contacts are laminated to the insulator at the ends.</p> <p>Does the eDP flex cable show signs of damage?</p>	Yes	Go to step 6.	\$(nodeText.yesSymptomCode)	
		No	Go to step 7.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
6.	<p>Inspect the eDP connectors on the logic board and TCON assembly for damage.</p> <p>Is the eDP connector on the logic board or TCON also damaged?</p>	Yes	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	
		No	<p>Replace eDP flex cable.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	X03	INTERNAL CABLE
7.	Inspect the eDP connector on the logic board for damage.	Yes	Go to step 8.	\$(nodeText.yesSymptomCode)	
	Does the connector on the logic board show signs of damage?	No	Go to step 9.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
8.	Inspect the connector on the eDP flex cable for damage.	Yes	ESCALATION REQUIRED. Contact CSS for additional support or a multipart repair.	X99	
	Is the connector on the eDP flex cable also damaged?	No	Replace the logic board and Touch ID board. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair. Verify that the issue is resolved.	M24	MLB
9.	Inspect the eDP connector on the TCON assembly for damage.	Yes	Go to step 10.	\${nodeText.yesSymptomCode}	
	Does the connector on the TCON show signs of damage?	No	Go to step 11.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
10.	<p>Inspect the connector on the eDP flex cable for damage.</p> <p>Is the connector on the eDP flex cable also damaged?</p>	Yes	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	
		No	<p>Replace the display assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	L14	LCD
11.	<p>Reseat the eDP flex cable connector on the logic board. Reseating the cable can restore display functionality. Retest the internal display with a normal startup or the Display Anomalies test suite in Apple Service Toolkit 2 (AST 2).</p> <p>An NVRAM reset may be required if the brightness was lowered in previous troubleshooting steps.</p> <p>Did reseating the cable resolve the issue?</p>	Yes	The issue was resolved by reseating the eDP flex cable. Verify resolution.	\${nodeText.yesSymptomCode}	
		No	Go to step 12.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
12.	<p>Troubleshooting this issue completely requires a known-good eDP flex cable.</p> <p>Do you have immediate access to a known-good eDP flex cable?</p>	Yes	Go to step 13.	\$(nodeText.yesSymptomCode)	
		No	<p>Replace eDP flex cable.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	X03	INTERNAL CABLE
13.	<p>Substitute a known-good eDP flex cable and attempt to reproduce the issue.</p> <p>Was the issue resolved with the known-good eDP flex cable?</p>	Yes	<p>Replace eDP flex cable.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	X03	INTERNAL CABLE
		No	Go to step 14.	\$(nodeText.noSymptomCode)	
14.	<p>Troubleshooting this issue completely requires a known-good display assembly.</p> <p>Do you have immediate access to a known-good display assembly?</p>	Yes	Go to step 15.	\$(nodeText.yesSymptomCode)	
		No	Go to step 16.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
15.	Substitute a known-good display assembly and attempt to reproduce the issue. Was the issue resolved with the known-good display assembly?	Yes	Go to step 16.	\${nodeText.yesSymptomCode}	
		No	Replace the logic board and Touch ID board. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair. Verify that the issue is resolved.	M04	MLB
16.	Isolate the original symptom for this issue as: <ul style="list-style-type: none"> • Full-screen flicker or flash Does this symptom best describe the original issue?	Yes	Replace the display assembly. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair. Verify that the issue is resolved.	L06	LCD
		No	Go to step 17.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
17.	<p>Isolate the original symptom for this issue as:</p> <ul style="list-style-type: none"> Distorted, blurred, or out-of-focus video <p>Does this symptom best describe the original issue?</p>	Yes	<p>Replace the display assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	L04	LCD
		No	Go to step 18.	\${nodeText.noSymptomCode}	
18.	<p>Isolate the original symptom for this issue as:</p> <ul style="list-style-type: none"> Cannot change display resolution <p>Does this symptom best describe the original issue?</p>	Yes	<p>Replace the display assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	L10	LCD
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	

	Check	Result	Action	Code	Commodity
19.	Restart the computer and verify the image on the internal display, backlight, camera, and ambient light sensor are functioning normally.	Yes	The issue is resolved.	\$(nodeText.yesSymptomCode}	
	Run AST 2 Full System Diagnostic (EFI & OS), if available, to ensure no other issues remain. Are all issues resolved?	No	ESCALATION REQUIRED. Contact CSS for additional support or a multipart repair.	M04	

Cracked Display

Unlikely causes:

There are no unlikely causes for this issue.

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">Cracked LCD display	<p>If possible, run the AST or AST 2 Mac Resource Inspector (MRI) diagnostic suite prior to troubleshooting. Check for any service restrictions in the diagnostic results.</p> <p>1. Refer to guidelines in TP1138: Visual/Mechanical Inspection (VMI) Guide for Mac Displays.</p> <p>Note: Inform the user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>

Deep Dive

	Check	Result	Action	Code	Commodity
1.	Determine whether issue involves a safety risk, such as glass fragments.	Yes	ESCALATION REQUIRED. Contact CSS for safety-related issues. Refer to OP44: Handling Potential Product Safety Issues . Retail: Document the issue and escalate following the steps in RS60: Product Safety Escalations .	X99	
	Do not perform procedures that can be a safety risk to you or the user.				
	Have you identified a safety issue?	No	Go to step 2.	\${nodeText.noSymptomCode}	
2.	Refer to TP1138: Visual/Mechanical Inspection (VMI) Guide for Mac Displays .	Yes	Go to step 3.	\${nodeText.yesSymptomCode}	
	Use the Visual/Mechanical Inspection (VMI) Guide to identify conditions that affect warranty and service eligibility.	No	Go to step 4.	\${nodeText.noSymptomCode}	
	Is the computer in warranty and eligible for warranty service?				

	Check	Result	Action	Code	Commodity
3.	Determine whether the display has a single crack or multiple cracks in the LCD. Refer to TP1138: Visual/Mechanical Inspection (VMI) Guide for Mac Displays for specific instructions and criteria. Does the display have a single crack or multiple cracks in the LCD?	Single	Replace the display assembly.	L35	LCD
		Multiple	Replace the display assembly out of warranty.	L36	LCD
4.	Determine whether the computer is eligible for out-of-warranty service or is ineligible for service. Is the computer eligible for out-of-warranty service?	Yes	Go to step 5.	\${nodeText.yesSymptomCode}	
		No	Return computer to user. Due to damage, the computer is no longer eligible for support.	\${nodeText.noSymptomCode}	
5.	Determine whether the display has a single crack or multiple cracks in the LCD. Refer to TP1138: Visual/Mechanical Inspection (VMI) Guide for Mac Displays for specific instructions and criteria. Does the display have a single crack or multiple cracks in the LCD?	Single	Replace the display assembly.	L35	LCD
		Multiple	Replace the display assembly out of warranty.	L36	LCD

Display Anomalies

Unlikely causes:

Bottom case, duckhead, fans, keyboard flex cable, I/O boards, audio board, power adapter, top case assembly, USB-C charging cable, vent/antenna module.

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">• Distorted or blurred image• Pixel anomalies• Vertical/horizontal lines• Unstable flickering• Incorrect or missing colors• Nonuniform brightness at specific location• Vertical lines of nonuniform brightness repeating over the display• Image persistence or image sticking on screen• Light leakage around the display <p>Note: Inform the user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw.</p> <p>Important: Follow instructions in TP1138: Visual/Mechanical Inspection (VMI) Guide for Mac Displays to identify conditions that affect warranty and service eligibility.</p> <p>Note: This procedure is intended for display issues with the main display only. If the user has display issues with the Touch Bar display, return to the list of symptoms and choose “Touch Bar Issues” from the troubleshooting menu.</p> <p>Note: Verify the issue after using the computer for a few minutes to warm it, or by following steps in HT207571: Warm a Mac for testing. Doing this may help identify intermittent issues.</p> <ol style="list-style-type: none">1. Compare an image on user’s display with the same image on an equivalent, known-good portable computer display. Small variations in display quality are normal and expected and may not indicate a service issue.2. Clean the glass panel and check for dust or debris.3. Check the brightness setting.4. Verify that System Preferences > Universal Access > Seeing > Enhance Contrast is set to Normal.5. Check System Preferences > Displays > Color for possible use of a custom display profile. Set profile to Color LCD.6. Use macOS Recovery to troubleshoot potential software issues. Hold down Command-R during startup to restart from the recovery partition. See HT201314: About macOS Recovery.7. Refer to HT201260: Find out which macOS your Mac is using to check that the system build is correct for this computer model. Check for and apply the latest software and firmware updates, especially those that deal with display or graphic issues.8. Reset the NVRAM using the procedure for this computer in HT204063: Reset NVRAM or PRAM on your Mac.9. Reset the SMC using the procedure listed for this computer in HT201295: How to reset the System Management Controller (SMC) on your Mac.

Deep Dive

	Check	Result	Action	Code	Commodity
1.	Use the Display Anomalies test suite in Apple Service Toolkit (AST) 2 or compare an image on the user's display with the same image on an equivalent, known-good display.	Yes	Go to the "Corrupted or Distorted Video" troubleshooting flow.	\$(nodeText.yesSymptomCode)	
	<p>Of the eight issues below, determine if "distorted/blurred image" or "unstable flickering" best describes the primary symptom:</p> <ul style="list-style-type: none"> • Distorted/blurred image • Unstable flickering • Vertical/horizontal lines • Pixel anomalies • Nonuniform brightness • Incorrect or missing colors • Light leakage around the display • Image persistence or image sticking on screen <p>Is the primary issue either distortion or flickering of the display image?</p>	No	Go to step 2.	\$(nodeText.noSymptomCode)	
2.	Follow steps in Restore Apple T2 firmware on 2018 MacBook Pro to restore the T2 firmware on the user's computer.	Yes	Go to step 3.	\$(nodeText.yesSymptomCode)	
	<p>Restart the computer and verify that it completely starts up to macOS.</p> <p>Retest the display.</p> <p>Does the issue persist after restoring T2 firmware?</p>	No	The issue was resolved by restoring T2 firmware.	\$(nodeText.noSymptomCode)	
3.	Use the Display Anomalies test suite in AST 2 or compare an image on the user's display with the same image on an equivalent, known-good display.	Yes	Go to step 4.	\$(nodeText.yesSymptomCode)	
	<p>Of the six issues below, determine if "vertical/horizontal lines" or "pixel anomalies" best describes the primary symptom:</p> <ul style="list-style-type: none"> • Vertical/horizontal lines • Pixel anomalies • Nonuniform brightness • Incorrect or missing colors • Light leakage around the display • Image persistence or image sticking on screen <p>Does the primary issue involve either lines or pixels?</p>	No	Go to step 21.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
4.	Thoroughly clean the display surface to remove any dust or debris.	Yes	The issue has been resolved. Verify resolution.	\$(nodeText.yesSymptomCode)	
	Examine the cleaned display and try to reproduce the issue.	No	Go to step 5.	\$(nodeText.noSymptomCode)	
	Was the issue resolved by cleaning the display?				
5.	Shut down the unit and examine the area of the display that is affected by the symptom under a bright light source.	Yes	Replace the display assembly.	L19	LCD
	Check that the affected area is not damaged by scratches, pits, or damage to the coating of the display.		Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.		
	Refer to TP1138: Visual/Mechanical Inspection (VMI) Guide for Mac Displays for more information.				
6.	Does the display surface appear damaged?	Yes	Verify that the issue is resolved.		
		No	Go to step 6.	\$(nodeText.noSymptomCode)	
7.	Start an AST 2 session with the unit and run the Display Anomalies test suite.	Yes	Go to step 7.	\$(nodeText.yesSymptomCode)	
	If AST 2 is not available, attempt to view the affected area against a number of solid-color backgrounds. Use System Preferences > Desktop & Screen Saver > Desktop, and select “Solid Colors” under “Apple” in the left column.	No	The display is within specification.	\$(nodeText.noSymptomCode)	
	Is the issue verified?				
7.	Disconnect and inspect the eDP flex cable for damage. Pay attention to the body of the cable, looking for pinching or crimping; also check both ends of the cable, examining where the contacts are laminated to the insulator at the ends.	Yes	Go to step 8.	\$(nodeText.yesSymptomCode)	
		No	Go to step 9.	\$(nodeText.noSymptomCode)	
	Does the eDP flex cable show signs of damage?				

	Check	Result	Action	Code	Commodity
8.	<p>Inspect the eDP connectors on the logic board and TCON assembly for damage.</p> <p>Is the eDP connector on the logic board or TCON also damaged?</p>	Yes	Go to step 9.	\$(nodeText.yesSymptomCode)	
		No	<p>Replace eDP (Embedded DisplayPort) flex cable.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	X03	INTERNAL CABLE
9.	Inspect the eDP connector on the logic board for damage.	Yes	Go to step 10.	\$(nodeText.yesSymptomCode)	
	Does the connector on the logic board show signs of damage?	No	Go to step 11.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
10.	<p>Inspect the connector on the eDP flex cable for damage.</p> <p>Is the connector on the eDP flex cable also damaged?</p>	Yes	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	
		No	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M24	MLB
11.	Inspect the eDP connector on the TCON assembly for damage.	Yes	Go to step 12.	\${nodeText.yesSymptomCode}	
	Does the connector on the TCON show signs of damage?	No	Go to step 13.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
12.	<p>Inspect the connector on the eDP flex cable for damage.</p> <p>Is the connector on the eDP flex cable also damaged?</p>	Yes	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	
		No	<p>Replace the display assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	L14	LCD
13.	<p>Reseat the eDP flex cable connection on the logic board. Reseating the cable can restore display functionality. Retest the internal display with a normal startup or the Display Anomalies test suite in AST 2.</p> <p>Is the affected area now free of stuck/dead pixels or lines?</p>	Yes	The issue was resolved by reseating the eDP flex cable. Verify resolution.	\${nodeText.yesSymptomCode}	
		No	Go to step 14.	\${nodeText.noSymptomCode}	
14.	<p>Examine the affected area of the screen and determine whether it appears to be affected by a pixel issue (bright, dark, or foreign material) or an anomalous line (horizontal or vertical).</p> <p>Is the issue in question a vertical or horizontal line or band?</p>	Yes	Go to step 16.	\${nodeText.yesSymptomCode}	
		No	Go to step 15.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
15.	<p>Use the Display Anomalies test suite in AST 2 to find all pixel anomalies present.</p> <p>If AST 2 is not available, use a solid desktop background in System Preferences > Desktop & Screen Saver.</p> <p>Refer to HT202025: About LCD display pixel anomalies for Apple products released in 2010 and later to determine whether the number of defects in display exceeds specification.</p> <p>Does the number of pixel anomalies exceed the specified limit?</p>	Yes	<p>Replace the display assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	L20	LCD
		No	The display is within specification.	\$(nodeText.noSymptomCode)	
16.	<p>Run Mac Resource Inspector (MRI) from AST 2 to check if the display is fully recognized by the computer.</p> <p>Is display hardware detected in MRI?</p>	Yes	Go to step 17.	\$(nodeText.yesSymptomCode)	
		No	Go to step 18.	\$(nodeText.noSymptomCode)	
17.	<p>Connect a known-good external display using a USB-C VGA or Digital AV MultiPort Adapter and restart the computer.</p> <p>Does the external display exhibit the same symptom as the internal display?</p>	Yes	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M31	MLB
		No	Go to step 18.	\$(nodeText.noSymptomCode)	
18.	<p>Troubleshooting this issue completely requires a known-good logic board.</p> <p>Do you have immediate access to a known-good logic board?</p>	Yes	Go to step 19.	\$(nodeText.yesSymptomCode)	
		No	Go to step 20.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
19.	<p>Substitute a known-good logic board. Restart the unit and check the display for any change in symptoms.</p> <p>Is a normal image restored on the display?</p>	Yes	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M04	MLB
		No	Go to step 20.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
20.	Observe the symptom on the display and determine whether the lines are vertical or horizontal.	Yes	<p>Replace the display assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	L27	LCD
	Are the lines on the display vertical?	No	<p>Replace the display assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	L26	LCD
21.	Use the Display Anomalies test suite in AST 2 or compare an image on the user's display with the same image on an equivalent, known-good display.	Yes	Go to step 22.	\$(nodeText.yesSymptomCode)	
	<p>Of the four issues below, determine if "nonuniform brightness" best describes the primary symptom:</p> <ul style="list-style-type: none"> • Nonuniform brightness • Incorrect or missing colors • Light leakage around the display • Image persistence or image sticking on screen <p>Is the primary issue nonuniform brightness?</p>	No	Go to step 32.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
22.	Disconnect and inspect the eDP flex cable for damage. Pay attention to the body of the cable, looking for pinching or crimping; also check both ends of the cable, examining where the contacts are laminated to the insulator at the ends. Does the eDP flex cable show signs of damage?	Yes	Go to step 23.	\${nodeText.yesSymptomCode}	
		No	Go to step 24.	\${nodeText.noSymptomCode}	
23.	Inspect the eDP connectors on the logic board and TCON assembly for damage. Is the eDP connector on the logic board or TCON also damaged?	Yes	ESCALATION REQUIRED. Contact CSS for additional support or a multipart repair.	X99	
		No	Replace eDP (Embedded DisplayPort) flex cable. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair. Verify that the issue is resolved.	X03	INTERNAL CABLE
24.	Inspect the eDP connector on the logic board for damage. Does the connector on the logic board show signs of damage?	Yes	Go to step 25.	\${nodeText.yesSymptomCode}	
		No	Go to step 26.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
25.	Inspect the connector on the eDP flex cable for damage. Is the connector on the eDP flex cable also damaged?	Yes	ESCALATION REQUIRED. Contact CSS for additional support or a multipart repair.	X99	
		No	Replace the logic board and Touch ID board. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair. Verify that the issue is resolved.	M24	MLB
26.	Inspect the eDP connector on the TCON assembly for damage.	Yes	Go to step 27.	\${nodeText.yesSymptomCode}	
	Does the connector on the TCON show signs of damage?	No	Go to step 28.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
27.	<p>Inspect the connector on the eDP flex cable for damage.</p> <p>Is the connector on the eDP flex cable also damaged?</p>	Yes	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	
		No	<p>Replace the display assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	L14	LCD
28.	<p>Reseat the eDP flex cable connector on the logic board and display. Reseating the cable can restore display functionality. Retest the internal display with a normal startup or the Display Anomalies test suite in AST 2.</p>	Yes	The issue was resolved by reseating the eDP flex cable. Verify resolution.	\${nodeText.yesSymptomCode}	
	<p>Is the display brightness now uniform and correct across the entirety of the display?</p>	No	Go to step 29.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
29.	<p>Examine the image on the display closely and determine whether the uneven brightness is located on a single location or repeats over the display.</p> <p>Is the nonuniform brightness repeating over the entire display?</p>	Yes	Go to step 30.	\$(nodeText.yesSymptomCode)	
		No	<p>Replace the display assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	L21	LCD
30.	<p>Troubleshooting this issue completely requires a known-good logic board.</p> <p>Do you have immediate access to a known-good logic board?</p>	Yes	Go to step 31.	\$(nodeText.yesSymptomCode)	
		No	<p>Replace the display assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	L21	LCD

	Check	Result	Action	Code	Commodity
31.	Substitute a known-good logic board. Restart the unit and check the display for any change in symptoms.	Yes	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M25	MLB
	Is a normal image restored on the display?	No	<p>Replace the display assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	L21	LCD
32.	Use the Display Anomalies test suite in AST 2 or compare an image on the user's display with the same image on an equivalent, known-good display.	Yes	Go to step 33.	\$(nodeText.yesSymptomCode)	
	<p>Of the three issues below, determine if "incorrect or missing colors" best describes the primary symptom:</p> <ul style="list-style-type: none"> • Incorrect or missing colors • Light leakage around the display • Image persistence or image sticking on screen <p>Is the primary issue incorrect or missing colors?</p>	No	Go to step 39.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
33.	Verify that the display is listed in System Information > Hardware > Graphics/Displays. This ensures that the color profile can be matched with the LCD. Is the display hardware detected?	Yes	Go to step 34.	\$(nodeText.yesSymptomCode)	
		No	Go to step 35.	\$(nodeText.noSymptomCode)	
34.	Go to System Preferences > Displays > Color to ensure that Color LCD is selected under the display profile. Inspect the display again for incorrect or missing colors. Did changing the display profile correct the issue?	Yes	The issue was resolved by setting a valid display profile. The user may have created an off-color calibration setting. Verify resolution.	\$(nodeText.yesSymptomCode)	
		No	Go to step 35.	\$(nodeText.noSymptomCode)	
35.	Run the MRI test suite in AST 2 to verify that the computer properly detects the display hardware. Is the display detected in MRI?	Yes	Go to step 36.	\$(nodeText.yesSymptomCode)	
		No	Go to step 37.	\$(nodeText.noSymptomCode)	
36.	Reseat the eDP flex cable connector on the logic board. Reseating the cable can restore display functionality. Retest the internal display with a normal startup or the Display Anomalies test suite in AST 2. Is the color issue resolved?	Yes	The issue was resolved by reseating the eDP flex cable. Verify resolution.	\$(nodeText.yesSymptomCode)	
		No	Go to step 37.	\$(nodeText.noSymptomCode)	
37.	Troubleshooting this issue completely requires a known-good logic board. Do you have immediate access to a known-good logic board?	Yes	Go to step 38.	\$(nodeText.yesSymptomCode)	
		No	Replace the display assembly. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair. Verify that the issue is resolved.	L02	LCD

	Check	Result	Action	Code	Commodity
38.	Substitute a known-good logic board and retest the issue with a normal startup or by using the Display Anomalies test suite in AST 2.	Yes	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M04	MLB
	Did replacing the logic board resolve the issue?	No	<p>Replace the display assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	L02	LCD
39.	Use the Display Anomalies test suite in AST 2 or compare an image on the user's display with the same image on an equivalent, known-good display.	Yes	Go to step 40.	\$(nodeText.yesSymptomCode)	
	<p>Of the two issues below, determine if "light leakage around the display" best describes the primary symptom:</p> <ul style="list-style-type: none"> • Light leakage around the display • Image persistence or image sticking on screen <p>Is the primary issue light leakage around the display?</p>	No	Go to step 42.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
40.	<p>Troubleshooting this issue completely requires a known-good display assembly.</p> <p>Do you have immediate access to a known-good display assembly?</p>	Yes	Go to step 41.	\${nodeText.yesSymptomCode}	
		No	<p>Replace the display assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	L28	LCD
41.	<p>Substitute a known-good display assembly and retest the issue with a normal startup or by using the Display Anomalies test suite in AST 2.</p> <p>Did replacing the display assembly resolve the issue?</p>	Yes	<p>Replace the display assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	L28	LCD
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	L28	

	Check	Result	Action	Code	Commodity
42.	<p>A display might show a temporary faint remnant of a previous image even after a new image replaces it. Follow procedure in TP949: Image Persistence Test to determine if display fails or passes the Image Persistence Test.</p> <p>Does the display fail the Image Persistence Test?</p>	Yes	<p>Replace the display assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	L25	LCD
		No	<p>The display is within specification. Do not replace display assembly.</p>	\$(nodeText.noSymptomCode)	
43.	<p>Verify that the display issue or anomaly is no longer present.</p> <p>Run AST 2 Full System diagnostic suites (EFI & OS), if available, to ensure no other issues remain.</p> <p>Is the issue resolved?</p>	Yes	The issue is resolved.	\$(nodeText.yesSymptomCode)	
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	

Power But No Video

Unlikely causes:

Bottom case, duckhead, fans, keyboard flex cable, I/O boards, audio board, power adapter, top case assembly, USB-C charging cable, vent/antenna module.

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">Unit turns on, but no video is present on built-in displayVideo is present on external display but not on built-in displayNo video is present on built-in display but Caps Lock key illuminates when pressed <p>Note: Inform the user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw.</p> <p>Note: This procedure is intended for display issues with the main display only. If the user has display issues with the Touch Bar display only, return to the list of symptoms and choose “Touch Bar Issues” from the troubleshooting menu. If the user has display issues with both displays, continue troubleshooting.</p> <ol style="list-style-type: none">1. Disconnect all peripherals.2. Attempt to reset NVRAM using the procedure for this computer in HT204063: Reset NVRAM or PRAM on your Mac. Note: If the user’s computer is using a firmware password, this key combination does nothing or causes the computer to start up from macOS Recovery.3. Under certain circumstances, if the user had previously turned the main display brightness all the way down, the display may remain at the same brightness level upon restart. If the computer was configured to automatically log in, the Touch Bar display will activate after startup. You can then increase the main display brightness again using Touch Bar controls, which may resolve the user’s issue. However, if the computer was configured to not automatically log in, the Touch Bar display will not activate until after the user has entered login credentials at the macOS login screen. To verify this possibility and continue, have the user attempt to log in anyway, without being able to see the screen. First, hold Command and triple-press the Touch ID power button on the user’s computer. This turns on VoiceOver, which provides spoken feedback and can help determine when login credentials have been entered correctly. Refer to HT204434: Mac accessibility shortcuts for more information. Next, have the user carefully type the first letter of the login name, press the Enter or Return key on the keyboard, then type the password and press the Enter or Return key again.4. If the previous steps do not allow the user to log in and increase the brightness level using Touch Bar controls, then press and hold the power button to shut down the computer, and restart to macOS Recovery. See HT201314: About macOS Recovery.

Deep Dive

	Check	Result	Action	Code	Commodity
1.	<p>Follow steps in Apple Configurator 2 User Guide to restore the T2 firmware on the user's computer.</p> <p>Restart the computer and verify that it completely starts up to macOS.</p> <p>Retest the display.</p> <p>Does the issue persist after restoring T2 firmware?</p>	Yes	Go to step 2.	\$(nodeText.yesSymptomCode)	
		No	The issue was resolved by restoring T2 firmware.	\$(nodeText.noSymptomCode)	
2.	<p>Connect a known-good external display, keyboard, and mouse with a known-good USB-C VGA or Digital AV Multiport Adapter. Turn on the computer and close the display assembly. Use an external keyboard or mouse to ensure that the unit stays awake and check to see if the external display correctly displays video.</p> <p>Does the external display function normally?</p>	Yes	Go to step 3.	\$(nodeText.yesSymptomCode)	
		No	Go to the "No Video to External Display" troubleshooting flow.	\$(nodeText.noSymptomCode)	
3.	<p>Start up the computer normally. After cleaning the display glass of all fingerprints and dirt, shine a bright light on the display to illuminate it.</p> <p>The battery icon in the menu bar should always be visible and provide a reliable, high-contrast icon to look for.</p> <p>Does the display show a legible image despite not being backlit?</p>	Yes	Go to the "Backlight Issues or No Backlight" troubleshooting flow.	\$(nodeText.yesSymptomCode)	
		No	Go to step 4.	\$(nodeText.noSymptomCode)	
4.	<p>While observing the issue, move the display assembly back and forth.</p> <p>Does the symptom change with display movement?</p>	Yes	Go to step 5.	\$(nodeText.yesSymptomCode)	
		No	Go to step 14.	\$(nodeText.noSymptomCode)	
5.	<p>Disconnect and inspect the eDP flex cable for damage. Pay attention to the body of the cable, looking for pinching or crimping; also check both ends of the cable, examining where the contacts are laminated to the insulator at the ends.</p> <p>Does the eDP flex cable show signs of damage?</p>	Yes	Go to step 6.	\$(nodeText.yesSymptomCode)	
		No	Go to step 7.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
6.	<p>Inspect the eDP connectors on the logic board and TCON assembly for damage.</p> <p>Is the eDP connector on the logic board or TCON also damaged?</p>	Yes	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	
		No	<p>Replace eDP (Embedded DisplayPort) flex cable.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system.</p> <p>Verify that the issue is resolved.</p>	X03	INTERNAL CABLE
7.	Inspect the eDP connector on the logic board for damage.	Yes	Go to step 8.	\$(nodeText.yesSymptomCode)	
	Does the connector on the logic board show signs of damage?	No	Go to step 9.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
8.	Inspect the connector on the eDP flex cable for damage. Is the connector on the eDP flex cable also damaged?	Yes	ESCALATION REQUIRED. Contact CSS for additional support or a multipart repair.	X99	
		No	Replace the logic board and Touch ID board. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Verify that the issue is resolved.	M24	MLB
9.	Inspect the eDP connector on the TCON assembly for damage.	Yes	Go to step 10.	`\${nodeText.yesSymptomCode}`	
	Does the connector on the TCON show signs of damage?	No	Go to step 11.	`\${nodeText.noSymptomCode}`	
10.	Inspect the connector on the eDP flex cable for damage. Is the connector on the eDP flex cable also damaged?	Yes	ESCALATION REQUIRED. Contact CSS for additional support or a multipart repair.	X99	
		No	Replace the display assembly. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Verify that the issue is resolved.	L14	LCD

	Check	Result	Action	Code	Commodity
11.	Reseat the eDP flex cable connector on the logic board. Reseating the cable can restore display functionality. Retest the internal display with a normal startup or the Display Anomalies test suite in AST 2.	Yes	The issue was resolved by reseating the eDP flex cable. Verify resolution.	\$(nodeText.yesSymptomCode)	
	An NVRAM reset may be required if the brightness was lowered in previous troubleshooting steps.	No	Go to step 12.	\$(nodeText.noSymptomCode)	
	Did reseating the cable resolve the issue?				
12.	Troubleshooting this issue completely requires a known-good eDP flex cable. Do you have immediate access to a known-good eDP flex cable?	Yes	Go to step 13.	\$(nodeText.yesSymptomCode)	
		No	Replace eDP (Embedded DisplayPort) flex cable. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Verify that the issue is resolved.	X03	INTERNAL CABLE
13.	Substitute a known-good eDP flex cable and attempt to reproduce the issue. Was the issue resolved with the known-good eDP flex cable?	Yes	Replace eDP (Embedded DisplayPort) flex cable. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Verify that the issue is resolved.	X03	INTERNAL CABLE
		No	Go to step 14.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
14.	<p>Troubleshooting this issue completely requires a known-good display assembly.</p> <p>Do you have immediate access to a known-good display assembly?</p>	Yes	Go to step 15.	\${nodeText.yesSymptomCode}	
		No	<p>Replace the display assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system.</p> <p>Verify that the issue is resolved.</p>	L03	LCD
15.	<p>Substitute a known-good display assembly and attempt to reproduce the issue.</p> <p>Was the issue resolved with the known-good display assembly?</p>	Yes	<p>Replace the display assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system.</p> <p>Verify that the issue is resolved.</p>	L03	LCD
		No	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system.</p> <p>Verify that the issue is resolved.</p>	M03	MLB

	Check	Result	Action	Code	Commodity
16.	Restart the computer and verify the image on the internal display, backlight, camera, and ambient light sensor are functioning normally.	Yes	The issue is resolved.	`\${nodeText.yesSymptomCode}`	
	Run AST 2 Full System Diagnostic (EFI & OS), if available, to ensure no other issues remain. Are all issues resolved?	No	ESCALATION REQUIRED. Contact CSS for additional support or a multipart repair.	M03	

Built-In Keyboard Does Not Work Properly

Unlikely causes:

Bottom case, Display assembly, AC Wall adapter (duckhead), eDP flex cable, Fan, Touch ID board, I/O board, Audio board, Power adapter, Power cord, USB-C charging cable, Vent/antenna module

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">Letters or characters repeat unexpectedlyLetters or characters do not appearOne or more keys feel “sticky” or do not respond in a consistent mannerOne or more keys feel stuck in down or up positionKey press feels uneven or stiffKey not responding / spongy / not going all the way downDelayed key returnKeycaps or key switch mechanisms broken or missingKeyboard locks upDisplayed characters do not match the keys pressed <p>Note: Inform the user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover and disconnected the battery.</p> <ol style="list-style-type: none">Press Caps Lock key to see if LED lights up, indicating at least a partial connection to logic board.In System Preferences > Keyboard > Input Sources, enable Show Input menu in menu bar. From Input menu in the menu bar, select Show Keyboard Viewer. Check if keystrokes on keyboard are recognized in Keyboard Viewer. If built-in keyboard is not functioning, use an external USB keyboard to perform this step.Confirm that correct keyboard layout is selected in System Preferences > Keyboard > Input Sources. Ensure that any keyboard accessibility features have been disabled by checking System Preferences > Accessibility > General and System Preferences > Accessibility > Keyboard.If a Bluetooth keyboard is present and paired with the unit, it may be overriding input commands from the built-in keyboard. Turn off Bluetooth temporarily to isolate the issue to the built-in keyboard.Reset the NVRAM using the procedure for this computer in HT204063: Reset NVRAM or PRAM on your Mac.If letters or characters repeat unexpectedly, then skip all remaining Quick Checks by replying “No” to continue troubleshooting with deep dive steps.If any of the following symptoms is observed, then follow keycap cleaning and replacement instructions in TP1659: Butterfly Mechanism Keycap Replacement. Try tapping each affected key before, after, and during the cleaning process. Doing so helps dislodge any debris that may be blocking normal key operation: <ul style="list-style-type: none">letters or characters do not appearkeys feel sticky or do not respond in a consistent mannera keycap is loose

Deep Dive

	Check	Result	Action	Code	Commodity
1.	Check the keyboard and keycaps for damage by referring to TP1151: Visual/Mechanical Inspection (VMI) Guide for Mac Computers - Table of Contents .	Yes	Go to step 2.	\$(nodeText.yesSymptomCode)	
		No	Go to step 3.	\$(nodeText.noSymptomCode)	
	Are there any damaged keycaps?				

	Check	Result	Action	Code	Commodity
2.	1. Refer to TP1659: Butterfly Mechanism Keycap Replacement to remove the affected keycaps. While the keycap is removed, perform the following steps:	Yes	Issue resolved by replacing keycaps. Verify resolution.	`\${nodeText.yesSymptomCode}`	
	<p>A. Clean the inner aluminum part of the keycap well to remove any liquid residue that may be present.</p> <p>B. Inspect the switch housing for damage. Keycaps can be replaced, but the switch housing cannot. A damaged switch housing requires replacement of the entire top case.</p> <p>2. Refer to TP1659: Butterfly Mechanism Keycap Replacement to replace the keycap. Do not reuse keycaps.</p> <p>3. Test the keycap butterfly mechanism to verify that it is functional.</p> <p>Retest the keyboard to verify that all keyboard keys function normally, and the affected keycap or keycaps no longer exhibit this specific symptom.</p> <p>Did this resolve the issue?</p>	No	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K27	KEYBOARD
3.	Follow steps in Apple Configurator 2 User Guide to restore the T2 firmware on the user's computer.	Yes	Go to step 4.	`\${nodeText.yesSymptomCode}`	
	<p>Restart the computer and verify that it completely starts up to macOS.</p> <p>Retest the keyboard.</p> <p>Does the issue persist after restoring T2 firmware?</p>	No	The issue was resolved by restoring T2 firmware.	`\${nodeText.noSymptomCode}`	
4.	Verify that the specific symptom with the user's built-in keyboard is best described as:	Yes	Go to step 5.	`\${nodeText.yesSymptomCode}`	
	<ul style="list-style-type: none"> Letters or characters repeat unexpectedly. <p>Does this specific symptom describe the issue?</p>	No	Go to step 6.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
5.	<p>1. Clean the keyboard thoroughly. Refer to HT205662: How to clean the keyboard of your MacBook or MacBook Pro.</p> <p>2. If cleaning the keyboard did not resolve the issue, then refer to TP1659: Butterfly Mechanism Keycap Replacement to remove the affected keycaps. While the keycap is removed, perform the following steps:</p> <p>A. Clean the inner aluminum part of the keycap well to remove any liquid residue that may be present.</p> <p>B. Inspect the switch housing for damage. Keycaps can be replaced, but the switch housing cannot. A damaged switch housing requires replacement of the entire top case.</p> <p>3. Refer to TP1659: Butterfly Mechanism Keycap Replacement to replace the keycap. Do not reuse keycaps.</p> <p>4. Test the keycap butterfly mechanism to verify that it is functional.</p> <p>Retest the keyboard to verify that all keyboard keys function normally, and the affected keycaps no longer exhibit this specific symptom.</p> <p>Did this resolve the issue?</p>	Yes	Issue resolved by cleaning.	`\${nodeText.yesSymptomCode}`	KEYBOARD
		No	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K61	
6.	<p>Verify that the specific symptom with the user's built-in keyboard is best described as:</p> <ul style="list-style-type: none"> One or more keys feel "sticky" or do not respond in a consistent manner. <p>Does this specific symptom describe the issue?</p>	Yes	Go to step 7.	`\${nodeText.yesSymptomCode}`	
		No	Go to step 8.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
7.	<p>1. Refer to HT205662: How to clean the keyboard of your MacBook or MacBook Pro to clean the keyboard. Tap each affected key before, after, and during the cleaning process. Doing so helps dislodge any debris that may be blocking normal key operation.</p> <p>2. If cleaning the keyboard did not resolve the issue, then refer to TP1659: Butterfly Mechanism Keycap Replacement to remove the affected keycaps. While the keycap is removed, perform the following steps:</p> <p>A. Clean the inner aluminum part of the keycap well to remove any liquid residue that may be present.</p> <p>B. Inspect the switch housing for damage. Keycaps can be replaced, but the switch housing cannot. A damaged switch housing requires replacement of the entire top case.</p> <p>3. Refer to TP1659: Butterfly Mechanism Keycap Replacement to replace the keycap. Do not reuse keycaps.</p> <p>4. Test the keycap butterfly mechanism to verify that it is functional.</p> <p>Retest the keyboard to verify that all keyboard keys function normally, and the affected keycaps no longer exhibit this specific symptom.</p> <p>Did this resolve the issue?</p>	Yes	Issue resolved by cleaning.	`\${nodeText.yesSymptomCode}`	KEYBOARD
		No	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K05	
8.	<p>Verify that the specific symptom with the user's built-in keyboard is best described as:</p> <ul style="list-style-type: none"> • Keys press feels uneven or stiff. • Keycap not responding / spongy / not going all the way down. • Delayed key return. <p>Does this specific symptom describe the issue?</p>	Yes	Go to step 10.	`\${nodeText.yesSymptomCode}`	
		No	Go to step 9.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
9.	Run the AST 2 Keyboard diagnostic suite to verify that all keys are functional, including modifier keys.	Yes	Go to step 10.	\$_{nodeText.yesSymptomCode}	
	<p>Note: Diagnostics only verify keyboard electrical operation. Diagnostics do not verify keyboard mechanical feel and response.</p> <p>If you have verified a mechanical issue with the user's keyboard and diagnostic tests pass, reply "Yes." Clean the keyboard around the affected key. Remove and discard any malfunctioning keycaps. Inspect, clean, and replace keycaps as necessary.</p> <p>Does the keyboard pass testing?</p>	No	Go to step 12.	\$_{nodeText.noSymptomCode}	
10.	Refer to HT205662: How to clean the keyboard of your MacBook or MacBook Pro to carefully apply compressed air to clean the keyboard.	Yes	Issue resolved by cleaning.	\$_{nodeText.yesSymptomCode}	
	<p>Use compressed air and spray around the affected key, in the space between the top case and the keycap.</p> <p>Retest the keyboard to verify that all keyboard keys function normally, and the affected keycap or keycaps no longer exhibit this specific symptom.</p> <p>Did this resolve the issue?</p>	No	Go to step 11.	\$_{nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
11.	<p>1. If cleaning the keyboard did not resolve the issue, then refer to TP1659: Butterfly Mechanism Keycap Replacement to remove the affected keycaps. While the keycap is removed, perform the following steps:</p> <p>A. Clean the inner aluminum part of the keycap well to remove any liquid residue that may be present.</p> <p>B. Inspect the switch housing for damage. Keycaps can be replaced, but the switch housing cannot. A damaged switch housing requires replacement of the entire top case.</p> <p>2. Refer to TP1659: Butterfly Mechanism Keycap Replacement to replace the keycap. Do not reuse keycaps.</p> <p>3. Test the keycap butterfly mechanism to verify that it is functional.</p> <p>Retest the keyboard to verify that all keyboard keys function normally, and that the affected keycaps no longer exhibit this specific symptom.</p> <p>Did this resolve the issue?</p>	Yes	Issue resolved by cleaning.	<code>\${nodeText.yesSymptomCode}</code>	KEYBOARD
		No	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K62	
12.	<p>A defective keyboard circuit or a liquid spill can result in some, or all, keys not responding when pressed. Examine diagnostic results from the previous step.</p> <p>Select the “No” answer if no keys respond.</p> <p>Select the “Yes” answer if one or more keys respond.</p> <p>Do any keys respond when pressed?</p>	Yes	Go to step 25.	<code>\${nodeText.yesSymptomCode}</code>	
		No	Go to step 13.	<code>\${nodeText.noSymptomCode}</code>	

	Check	Result	Action	Code	Commodity
13.	<p>A liquid spill can short key signals and stop keyboard operations. Visual inspection indicating liquid spills should be very obvious to you and to user.</p> <p>Note: Inform user that computer failures due to accidental damage are not covered, and if applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p> <p>Is it obvious that keyboard keys were exposed to a liquid spill?</p>	Yes	Go to step 14.	`\${nodeText.yesSymptomCode}`	
		No	Go to step 15.	`\${nodeText.noSymptomCode}`	
14.	<p>Determine whether liquid damage is limited to the top case or whether multiple parts are damaged.</p> <p>Is there liquid damage to multiple parts?</p>	Yes	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or for a multipart repair related to liquid spill observation found during repair.</p>	K90	
		No	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K90	KEYBOARD
15.	<p>Locate keyboard flex cable connector on logic board and verify keyboard flex cable is present and connected.</p> <p>Is flex cable present?</p>	Yes	Go to step 17.	`\${nodeText.yesSymptomCode}`	
		No	Go to step 16.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
16.	If keyboard flex cable is missing, it may be under logic board. Remove logic board to locate keyboard flex cable.	Yes	Issue resolved by reseating keyboard flex cable. Verify resolution.	`\${nodeText.yesSymptomCode}`	
	Reseat cable firmly to logic board. Reassemble computer.				
	Test all keyboard keys to verify operation. Start up using a known-good OS or run the Keyboard suite in AST 2 to verify.	No	Go to step 17.	`\${nodeText.noSymptomCode}`	
	Is keyboard now functioning?				
17.	Disconnect and inspect the keyboard flex cable and its connectors on both ends.	Yes	Go to step 18.	`\${nodeText.yesSymptomCode}`	
	Check for damage on the flex cable, the cable's connectors, and the top case and logic board connectors.				
	Inspect connector housings. Look for debris or broken/missing pins that might prevent proper seating.	No	Go to step 22.	`\${nodeText.noSymptomCode}`	
	Is there damage to keyboard flex cable or any connectors?				
18.	Determine whether damage is limited to one of the following components, or multiple parts are damaged: <ul style="list-style-type: none"> • keyboard flex cable • logic board • top case assembly 	Yes	ESCALATION REQUIRED. Contact CSS for additional support or a multipart repair.	X99	
	Is there damage to multiple parts?	No	Go to step 19.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
19.	<p>Inspect the keyboard flex cable for damage. Pay attention to the body of the cable, looking for pinching, tearing, or crimping, and to both ends of the cable, examining where the contacts are laminated to the insulator at the ends.</p> <p>Does the keyboard flex cable appear damaged?</p>	Yes	<p>Replace keyboard flex cable.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify the issue is resolved.</p>	X03	INTERNAL CABLE
		No	Go to step 20.	\${nodeText.noSymptomCode}	
20.	<p>Inspect the top case keyboard flex cable connector for damage.</p> <p>Does the top case keyboard flex cable connector appear damaged?</p>	Yes	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K16	KEYBOARD
		No	Go to step 21.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
21.	<p>Inspect the logic board keyboard flex cable connector for damage.</p> <p>Does the logic board keyboard flex cable connector appear damaged?</p>	Yes	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M24	MLB
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	
22.	<p>With keyboard flex cable reseated to logic board connector, reassemble computer.</p> <p>Run the AST 2 Keyboard diagnostic suite to verify that all keys are functional after repair, including modifier keys.</p> <p>Is keyboard now functioning?</p>	Yes	Issue resolved by reseating keyboard flex cable. Verify resolution.	<p>\${nodeText.yesSymptomCode}</p>	
		No	Go to step 23.	<p>\${nodeText.noSymptomCode}</p>	

	Check	Result	Action	Code	Commodity
23.	<p>Troubleshooting this issue completely requires a known-good top case assembly.</p> <p>Do you have immediate access to a known-good top case assembly?</p>	Yes	Go to step 24.	\${nodeText.yesSymptomCode}	
		No	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K11	KEYBOARD

	Check	Result	Action	Code	Commodity
24.	<p>Substitute a known-good top case assembly.</p> <p>Run the AST 2 Keyboard diagnostic suite to verify that all keys are functional after repair, including modifier keys.</p> <p>Is keyboard now functioning?</p>	Yes	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K11	KEYBOARD
		No	<p>Reinstall the user's top case.</p> <p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M16	MLB

	Check	Result	Action	Code	Commodity
25.	<p>Troubleshooting this issue completely requires a known-good top case assembly.</p> <p>Do you have immediate access to a known-good top case assembly?</p>	Yes	Go to step 26.	\${nodeText.yesSymptomCode}	
		No	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K01	KEYBOARD

	Check	Result	Action	Code	Commodity
26.	<p>Substitute a known-good top case assembly.</p> <p>Run the AST 2 Keyboard diagnostic suite to verify that all keys are functional after repair, including modifier keys.</p> <p>Is keyboard now functioning?</p>	Yes	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K01	KEYBOARD
		No	<p>Reinstall the user's top case</p> <p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M16	MLB
27.	<p>Restart the computer and verify that the keyboard is functioning normally.</p> <p>Run AST 2 Full System diagnostic suites (EFI & OS), if available, to ensure no other issues remain.</p> <p>Verify that the issue is resolved.</p> <p>Is issue resolved?</p>	Yes	The issue is resolved. Verify resolution.	\${nodeText.yesSymptomCode}	
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	

Built-in Keyboard Has Dim or No Keyboard Backlight

Unlikely causes:

Bottom case, Display assembly, AC Wall adapter (duckhead), eDP flex cable, Fan, Touch ID board, I/O board, Audio board, Power adapter, Power cord, USB-C charging cable, Vent/antenna module

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">All keyboard operation is normal except for backlight.Keyboard backlight is not detected in a darkened room.Keyboard backlight is uneven: some keys are dim or one or more keys are brighter than the others. <p>Note: Inform the user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover and disconnected the battery.</p> <p>Note: This procedure is intended for backlight issues with the keyboard only. If the user has backlight issues with the Touch Bar display, return to the list of symptoms and choose “Touch Bar Issues” from the troubleshooting menu.</p> <ol style="list-style-type: none">Refer to HT201260: Find out which macOS your Mac is using to check that the system build is correct for this computer model.Check System Preferences > Keyboard to see whether the “Adjust keyboard brightness in low light” option is available and checked. Refer to HT202310: Adjust the brightness of your backlit keyboard.The keyboard backlight is enabled only when the ambient light sensor (ALS) detects low light conditions. Check System Preferences > Displays to see whether the “Automatically adjust brightness” option is selected.Check ALS functionality by covering the sensor (located on the display assembly near the camera) with your hand to simulate a dark room. Check whether the keyboard backlight brightness increases.Keep the ALS covered and use controls to increase the keyboard backlight level.Reset the SMC using the procedure listed for this computer in HT201295: How to reset the System Management Controller (SMC) on your Mac. Do not hold in the power button when turning on the computer. You could inadvertently put the computer into DFU mode if you do.Reset the NVRAM using the procedure for this computer in HT204063: Reset NVRAM or PRAM on your Mac.

Deep Dive

	Check	Result	Action	Code	Commodity
1.	In AST 2, run the Keyboard test suite and verify that the keyboard backlight illuminates at the appropriate part of the test.	Yes	The issue cannot be duplicated.	<code>\$(nodeText.yesSymptomCode)</code>	
	Does the keyboard backlight pass testing?	No	Go to step 2.	<code>\$(nodeText.noSymptomCode)</code>	

	Check	Result	Action	Code	Commodity
2.	<p>Follow steps in Apple Configurator 2 User Guide to restore the T2 firmware on the user's computer.</p> <p>Restart the computer and verify that it completely starts up to macOS.</p> <p>Retest the keyboard backlight.</p> <p>Does the issue persist after restoring T2 firmware?</p>	Yes	Go to step 3.	`\${nodeText.yesSymptomCode}`	
		No	The issue was resolved by restoring T2 firmware.	`\${nodeText.noSymptomCode}`	
3.	<p>Locate keyboard flex cable connector on logic board and verify keyboard flex cable is present and connected.</p> <p>Is flex cable present?</p>	Yes	Go to step 5.	`\${nodeText.yesSymptomCode}`	
		No	Go to step 4.	`\${nodeText.noSymptomCode}`	
4.	<p>If keyboard flex cable is missing, it may be under logic board. Remove logic board to locate keyboard flex cable.</p> <p>Reseat cable firmly to logic board. Reassemble computer. Adjust keyboard backlight using controls. Cover ALS to activate keyboard backlight in a well lit area.</p> <p>Is keyboard backlight functioning?</p>	Yes	Issue resolved by reseating keyboard flex cable. Verify resolution.	`\${nodeText.yesSymptomCode}`	
		No	Go to step 5.	`\${nodeText.noSymptomCode}`	
5.	<p>Disconnect and inspect the keyboard flex cable and its connectors on both ends.</p> <p>Check for damage on the flex cable, the cable's connectors, and the top case and logic board connectors.</p> <p>Inspect connector housings. Look for debris or broken/missing pins that might prevent proper seating.</p> <p>Is there damage to keyboard flex cable or any connectors?</p>	Yes	Go to step 6.	`\${nodeText.yesSymptomCode}`	
		No	Go to step 10.	`\${nodeText.noSymptomCode}`	
6.	<p>Determine whether damage is limited to one of the following components, or multiple parts are damaged:</p> <ul style="list-style-type: none"> keyboard flex cable logic board top case assembly <p>Is there damage to multiple parts?</p>	Yes	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	
		No	Go to step 7.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
7.	<p>Inspect the keyboard flex cable for damage. Pay attention to the body of the cable, looking for pinching, tearing, or crimping, and to both ends of the cable, examining where the contacts are laminated to the insulator at the ends.</p> <p>Does the keyboard flex cable appear damaged?</p>	Yes	<p>Replace keyboard flex cable.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	X03	INTERNAL CABLE
		No	Go to step 8.	\${nodeText.noSymptomCode}	
8.	<p>Inspect the top case keyboard flex cable connector for damage.</p> <p>Does the top case keyboard flex cable connector appear damaged?</p>	Yes	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K16	KEYBOARD
		No	Go to step 9.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
9.	<p>Inspect the logic board keyboard flex cable connector for damage.</p> <p>Does the logic board keyboard flex cable connector appear damaged?</p>	Yes	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M24	MLB
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	
10.	<p>With keyboard flex cable reseated to logic board connector, reassemble computer.</p> <p>Retest in low light conditions to activate keyboard backlight. Adjust keyboard backlight using controls.</p> <p>Is keyboard backlight functioning?</p>	Yes	Issue resolved by reseating keyboard flex cable. Verify resolution.	\${nodeText.yesSymptomCode}	
		No	Go to step 11.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
11.	<p>Troubleshooting this issue completely requires a known-good top case assembly.</p> <p>Do you have immediate access to a known-good top case assembly?</p>	Yes	Go to step 12.	\${nodeText.yesSymptomCode}	
		No	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K10	KEYBOARD

	Check	Result	Action	Code	Commodity
12.	<p>Substitute a known-good top case assembly and retest in low light conditions that activate keyboard backlight. Adjust using F5 and F6 keys.</p> <p>Is keyboard backlight functioning?</p>	Yes	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K10	KEYBOARD
		No	<p>Reinstall the user's top case.</p> <p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M25	MLB
13.	<p>Restart the computer and verify that the keyboard backlight is functioning normally.</p> <p>Run AST 2 Full System diagnostic suites (EFI & OS), if available, to ensure no other issues remain.</p> <p>Verify that the issue is resolved.</p> <p>Is the issue resolved?</p>	Yes	Issue resolved.	\${nodeText.yesSymptomCode}	
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	

Built-in Trackpad Issues

Unlikely causes:

Bottom case, display assembly, duckhead, eDP flex cable, fans, keyboard flex cable, I/O boards, audio board, power adapter, USB-C charging cable, vent/antenna module.

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">Cursor does not move with trackpad input.Multi-Touch features are inoperable.Trackpad is not responding to clicks.Trackpad has Haptic feedback issues. <p>Note: Inform the user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw.</p> <ol style="list-style-type: none">Check HT201260: Find out which macOS your Mac is using to make sure system build is correct for this computer model. The trackpad will not function properly with an older build of macOS. Check for and apply the latest software and firmware updates. Note: You may have to connect a mouse and an external USB keyboard.Check for environmental factors such as humidity, hand lotion, or jewelry. Check to see whether the user is touching the trackpad simultaneously with both hands.With the computer off, clean the trackpad surface using a clean, dry, lint-free cloth.In System Preferences > Accessibility/Universal Access, disable all assisted “Keyboard” and “Mouse & Trackpad” settings. Retest trackpad functionality.In System Preferences > Trackpad, check and adjust Click pressure and Trackpad speed. Too-high or too-low settings may be perceived as trackpad issues.Disconnect all Bluetooth devices. In System Preferences > Bluetooth, click the ‘X’ button next to every device.If the issue occurs when the computer is running from a power adapter, try using a three-prong power cable rather than a two-prong duckhead.If the issue persists with a three-prong power cable, refer to HT203146: Troubleshooting unresponsive trackpad issues for further instructions.

Deep Dive

	Check	Result	Action	Code	Commodity
1.	Follow steps in Restore Apple T2 firmware on 2018 MacBook Pro to restore the T2 firmware on the user’s computer.	Yes	Go to step 2.	<code>\$(nodeText.yesSymptomCode)</code>	
	Restart the computer and verify that it completely starts up to macOS. Retest the keyboard backlight. Does the issue persist after restoring T2 firmware?	No	The issue was resolved by restoring T2 firmware.	<code>\$(nodeText.noSymptomCode)</code>	

	Check	Result	Action	Code	Commodity
2.	Run AST 2 Trackpad diagnostic suite.	Yes	Go to step 8.	\${nodeText.yesSymptomCode}	
	The diagnostic is Multi-Touch capable and will instruct you to touch every part of the trackpad surface to verify its Multi-Touch functionality. Does the computer pass Trackpad diagnostic suite?	No	Go to step 3.	\${nodeText.noSymptomCode}	
3.	Disconnect the trackpad flex cable from the logic board.	Yes	Go to step 4.	\${nodeText.yesSymptomCode}	
	Check for damage to the trackpad flex cable. Pay attention to the body of the cable, looking for tearing, pinching, or crimping. Check for damage to the trackpad logic board connector. Look for debris or broken or missing pins that might prevent proper seating. Is there damage to trackpad flex cable or any connectors?	No	Go to step 5.	\${nodeText.noSymptomCode}	
4.	Determine whether damage is limited to one of the following components, or whether multiple parts are damaged: <ul style="list-style-type: none">• trackpad flex cable• logic board Is the damage limited to the trackpad flex cable?	Yes	Replace the top case assembly with keyboard and trackpad. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair. Verify that the issue is resolved.	K16	KEYBOARD
		No	ESCALATION REQUIRED. Contact CSS for additional support or a multipart repair.	X99	

	Check	Result	Action	Code	Commodity
5.	<p>Carefully reseal trackpad flex cable into connector on the logic board.</p> <p>Run AST 2 Trackpad Diagnostic.</p> <p>Does computer pass Trackpad Diagnostic?</p>	Yes	<p>Issue resolved by reseating trackpad flex cable.</p> <p>Run AST 2 Trackpad Calibration Check to verify the proper functionality of the trackpad, as well as recalibrate it if necessary.</p> <p>Refer to TP1314: Trackpad Calibration Check for instructions.</p> <p>Verify that the issue is resolved.</p>	<p>Issue resolved by reseating trackpad flex cable.</p> <p>Run AST 2 Trackpad Calibration Check to verify the proper functionality of the trackpad, as well as recalibrate it if necessary.</p> <p>Refer to TP1314: Trackpad Calibration Check for instructions.</p> <p>Verify that the issue is resolved.</p>	
		No	Go to step 6.	<p>Issue resolved by reseating trackpad flex cable.</p> <p>Run AST 2 Trackpad Calibration Check to verify the proper functionality of the trackpad, as well as recalibrate it if necessary.</p> <p>Refer to TP1314: Trackpad Calibration Check for instructions.</p> <p>Verify that the issue is resolved.</p>	
6.	<p>Troubleshooting this issue completely requires a known-good top case with keyboard and trackpad.</p> <p>Do you have immediate access to a known-good top case with keyboard and trackpad?</p>	Yes	Go to step 7.	<p>Issue resolved by reseating trackpad flex cable.</p> <p>Run AST 2 Trackpad Calibration Check to verify the proper functionality of the trackpad, as well as recalibrate it if necessary.</p> <p>Refer to TP1314: Trackpad Calibration Check for instructions.</p> <p>Verify that the issue is resolved.</p>	
		No	<p>Replace the top case assembly with keyboard and trackpad.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	<p>Issue resolved by reseating trackpad flex cable.</p> <p>Run AST 2 Trackpad Calibration Check to verify the proper functionality of the trackpad, as well as recalibrate it if necessary.</p> <p>Refer to TP1314: Trackpad Calibration Check for instructions.</p> <p>Verify that the issue is resolved.</p>	KEYBOARD

	Check	Result	Action	Code	Commodity
7.	Substitute a known-good top case with keyboard and trackpad.	Yes	<p>Replace the top case assembly with keyboard and trackpad.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K11	KEYBOARD
	<p>Run AST 2 Trackpad Diagnostic.</p> <p>Does the computer pass Trackpad Diagnostic?</p>	No	<p>Reinstall the user's top case with keyboard and trackpad.</p> <p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M16	MLB

	Check	Result	Action	Code	Commodity
8.	<p>Instead of a standard button, this trackpad uses a force sensor to sense clicks, and a linear actuator to simulate the feeling of a click.</p> <p>Run AST 2 Trackpad Calibration Check to verify the proper functionality of these components, as well as to recalibrate them if necessary.</p> <p>Refer to TP1314: Trackpad Calibration Check for instructions.</p> <p>Important: The calibration check is a very sensitive diagnostic. It requires the use of 200 g and 800 g weights, and must be run on a very stable, flat, and undisturbed work surface. Disruptions to the work surface or misplacement of the weights may cause failures or incorrectly calibrate the trackpad.</p> <p>If the computer fails diagnostic on the first try, it is a good idea to run the diagnostic again after verifying proper weight placement, and that there is no disturbance to the work surface.</p> <p>Does the computer pass Trackpad Calibration Check?</p>	Yes	Go to step 9.	\${nodeText.yesSymptomCode}	
		No	Go to step 10.	\${nodeText.noSymptomCode}	
9.	<p>After running Trackpad Calibration Check, verify the functionality of the trackpad, since recalibration may have occurred.</p> <p>Is the trackpad functioning properly?</p>	Yes	Issue resolved. Verify resolution.	\${nodeText.yesSymptomCode}	
		No	<p>ESCALATION REQUIRED.</p> <p>If you suspect a problem even though the computer passed all trackpad diagnostics, contact CSS for additional support.</p>	K99	

	Check	Result	Action	Code	Commodity
10.	<p>Check the diagnostic results from Trackpad Calibration Check.</p> <p>Look for failures indicated with the actuator.</p> <p>Did the actuator fail calibration check?</p>	Yes	<p>Replace the top case assembly with keyboard and trackpad.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K29	KEYBOARD
		No	<p>Replace the top case assembly with keyboard and trackpad.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K13	KEYBOARD
11.	<p>Check trackpad functionality, including Multi-Touch, click, secondary click, and Force click. Also check keyboard functionality.</p> <p>For full verification, run the following AST 2 diagnostics:</p> <ul style="list-style-type: none"> Trackpad (Multi-Touch surface test) Trackpad Calibration Check Keyboard <p>Is the issue resolved?</p>	Yes	The issue is resolved. Verify resolution.	\${nodeText.yesSymptomCode}	
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	

Camera Issues

Unlikely causes:

Bottom case, AC Wall adapter (duckhead), Fan, Keyboard flex cable, Touch ID board, I/O board, Audio board, Power adapter, Power cord, Top case assembly, USB-C charging cable, Vent/antenna module

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">• Camera not detected• No green LED for camera• Excessive blooming in camera image• Poor white balance• Poor focus• Distorted or discolored image• Failure to respond to changing ambient light conditions <p>Note: Inform user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover and disconnected the battery.</p> <ol style="list-style-type: none">1. After display replacement, if the camera or ambient light sensor does not function, this could mean that the replacement display has not yet been configured for use. For complete instructions to configure a replacement display, refer to TP1657: System Configuration for Macs with the Apple T2 Security Chip. Always complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.2. Check for and apply latest software and firmware updates.3. Check HT201260: Find out which macOS your Mac is using to verify system build is correct for this computer model.4. Verify camera lens and glass panel are clear of contaminants.5. Ask user about lighting conditions in working environment. Dim lighting causes poor image quality. Overly bright lighting can bounce off surfaces onto subject and make image foggy.6. Striped, textured, and mesh clothing can create moiré patterns in image.7. Reset the SMC using the procedure listed for this computer in HT201295: How to reset the System Management Controller (SMC) on your Mac. Do not hold in the power button when turning on the computer. You could inadvertently put the computer into DFU mode if you do.8. Reset the NVRAM using the procedure for this computer in HT204063: Reset NVRAM or PRAM on your Mac.9. Disconnect all peripheral devices and restart computer.

Deep Dive

	Check	Result	Action	Code	Commodity
1.	Run Mac Resource Inspector diagnostic suite (MRI) and check test results to verify camera and display presence.	Yes	Go to step 3.	\$(nodeText.yesSymptomCode)	
	Does MRI detect camera and display?	No	Go to step 2.	\$(nodeText.noSymptomCode)	
2.	Look in System Information > Hardware > Camera, and verify “FaceTime HD Camera” is listed.	Yes	Go to step 3.	\$(nodeText.yesSymptomCode)	
	Does camera appear in System Information?	No	Go to step 4.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
3.	Open Photo Booth. Verify green LED next to camera lights up. Make sure image looks normal. Does camera LED light up and does image appear normal?	Yes	The issue cannot be duplicated.	`\${nodeText.yesSymptomCode}`	
		No	Go to step 4.	`\${nodeText.noSymptomCode}`	
4.	Follow steps in Apple Configurator 2 User Guide to restore the T2 firmware on the user's computer. Restart the computer and verify that it completely starts up to macOS. Retest the camera. Does the issue persist after restoring T2 firmware?	Yes	Go to step 5.	`\${nodeText.yesSymptomCode}`	
		No	The issue was resolved by restoring T2 firmware.	`\${nodeText.noSymptomCode}`	
5.	Follow Service Guide procedures to remove the bottom case and disconnect the battery from the logic board. Disconnect and inspect the eDP flex cable for damage. Pay attention to the body of the cable, looking for pinching or crimping; also check both ends of the cable, examining where the contacts are laminated to the insulator at the ends. Does the eDP flex cable show signs of damage?	Yes	Go to step 6.	`\${nodeText.yesSymptomCode}`	
		No	Go to step 7.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
6.	<p>Inspect the logic board and display TCON flex connectors for damage.</p> <p>Is the connector on the logic board or display also damaged?</p>	Yes	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	
		No	<p>Replace eDP flex cable.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	X03	INTERNAL CABLE
7.	Inspect the eDP connector on the logic board for damage.	Yes	Go to step 8.	`\${nodeText.yesSymptomCode}`	
	Does the connector on the logic board show signs of damage?	No	Go to step 9.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
8.	<p>Inspect the connector on the eDP flex cable for damage.</p> <p>Is the connector on the eDP flex cable also damaged?</p>	Yes	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	
		No	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M24	MLB
9.	Inspect the eDP connector on the TCON assembly for damage.	Yes	Go to step 10.	`\${nodeText.yesSymptomCode}`	
	Does the connector on the display show signs of damage?	No	Go to step 11.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
10.	<p>Inspect the connector on the eDP flex cable for damage.</p> <p>Is the connector on the eDP flex cable also damaged?</p>	Yes	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	
		No	<p>Replace the display assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	L14	LCD
11.	<p>Reseat the eDP flex cable connector on the logic board. Reseating the cable can restore camera functionality. Retest the camera with a normal startup or the Display Anomalies test suite in Apple Service Toolkit 2 (AST 2).</p> <p>An NVRAM reset may be required if the brightness was lowered in previous troubleshooting steps.</p> <p>Is camera functionality restored?</p>	Yes	<p>The issue was resolved by reseating the eDP flex cable.</p> <p>Run AST 2 Trackpad Calibration Check suite to verify the proper functionality of the trackpad, as well as recalibrate it if necessary.</p> <p>Refer to TP1314: Trackpad Calibration Check for instructions.</p> <p>Verify that the issue is resolved.</p>	<p>\$(nodeText.yesSymptomCode)</p>	
		No	Go to step 12.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
12.	<p>Troubleshooting this issue requires a known-good display assembly.</p> <p>Do you have immediate access to a known-good display assembly?</p>	Yes	Go to step 13.	\$(nodeText.yesSymptomCode)	
		No	<p>Replace the display assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	L17	LCD

	Check	Result	Action	Code	Commodity
13.	Substitute a known-good display assembly, and retest for camera functionality. Is camera functionality restored?	Yes	Replace the display assembly. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair. Verify that the issue is resolved.	L17	LCD
		No	Reinstall the user's display assembly. Replace the logic board and Touch ID board. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair. Verify that the issue is resolved.	M13	MLB
14.	Verify that camera now functions as expected and that image quality is normal. Run AST 2 Full System diagnostic suites (EFI & OS), if available, to ensure no other issues remain. Verify that the issue is resolved. Is the issue resolved?	Yes	Issue resolved.	`\${nodeText.yesSymptomCode}`	
		No	ESCALATION REQUIRED. Contact CSS for additional support or a multipart repair.	L99	

Distorted Audio from Internal Speakers

Unlikely causes:

Bottom case, display assembly, duckhead, eDP flex cable, fans, keyboard flex cable, I/O boards, audio board, power adapter, USB-C charging cable, vent/antenna module

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">• Sound is distorted, fuzzy, or crackly• Symptom only occurs with internal speakers• Symptom only occurs with external speakers or headphones <p>Note: Inform the user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw.</p> <ol style="list-style-type: none">1. Use controls to increase the sound volume to medium, halfway between minimum and maximum setting.2. In System Preferences > Sound > Output, verify “Internal Speaker” output is available and selected.3. Connect headphones or external speakers to the headphone jack. In System Preferences > Sound > Output, verify whether the Internal Speakers setting switches to Headphones, and whether audio can be played on headphones or external speakers.4. Disconnect any device connected to the headphone jack. In System Preferences > Sound > Output, check that the sound output device reverts to Internal Speakers and that the Balance slider is set halfway between left and right.5. If testing using iTunes, check that the equalizer is not turned on.6. Reset the NVRAM using the procedure for this computer in HT204063: Reset NVRAM or PRAM on your Mac.7. Test the audio output using more than one application or website.8. Refer to HT201260: Find out which macOS your Mac is using to check that the system build is correct for this computer model.9. Check for and apply the latest software and firmware updates.

Deep Dive

	Check	Result	Action	Code	Commodity
1.	Follow steps in Restore Apple T2 firmware on 2018 MacBook Pro to restore the T2 firmware on the user’s computer.	Yes	Go to step 2.	\$(nodeText.yesSymptomCode)	
	Restart the computer and verify that it completely starts up to macOS. Retest for speaker or headphone jack audio issue. Does the issue persist after restoring T2 firmware?	No	The issue was resolved by restoring T2 firmware.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
2.	Disconnect any connected headphones or external speakers. Go to System Preferences > Sound > Output tab and verify that Internal Speaker is available and selected for sound output. Does System Preferences list "Headphones" instead?	Yes	Go to step 3.	\$(nodeText.yesSymptomCode)	
		No	Go to step 4.	\$(nodeText.noSymptomCode)	
3.	Debris in, or damage to, the headphone jack can cause the computer to become stuck in Headphone or External Speaker mode. Use a lighted otoscope or magnifying glass to inspect for damage or debris inside the jack. Use compressed air to clean and remove any debris. Is there any damage to the headphone jack?	Yes	Replace the audio board. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair. Verify that the issue is resolved.	M24	OTHER BOARD
		No	Go to step 4.	\$(nodeText.noSymptomCode)	
4.	Run AST 2 Audio Test suite to verify that left and right speakers produce expected audio test patterns from each speaker. Refer to TP587: Using Audio Test . Does the computer pass AST 2 Audio Test suite?	Yes	ESCALATION REQUIRED. Contact CSS for additional support or a multipart repair.	X99	
		No	Go to step 5.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
5.	Follow Service Guide procedures to remove the bottom case and disconnect the battery from the logic board.	Yes	Go to step 6.	\$(nodeText.yesSymptomCode}	
	Locate speaker connections on logic board. Disconnect and inspect both speaker cable connectors and corresponding connectors on logic board for damage.	Both Speakers	Go to step 7.	\$(nodeText.noSymptomCode}	
	Reconnect the left and right speakers to the logic board, verifying that the connections are all seated properly.				
	Did you find damage to speakers or logic board connector?				
6.	Determine whether the damage is located on the speaker, the logic board, or a combination of multiple components. Is the damage limited to the speakers only?	Yes	Speakers are part of top case. Replace the top case assembly with keyboard and trackpad. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair. Verify that the issue is resolved.	K16	KEYBOARD
		No	ESCALATION REQUIRED. Contact CSS for additional support or a multipart repair.	X99	

	Check	Result	Action	Code	Commodity
7.	With speaker connectors reseated to logic board, verify you can hear audio through internal speakers.	Yes	The issue was resolved by reseating cables. Verify resolution.	\$(nodeText.yesSymptomCode)	
	In System Preferences > Sound > Output tab, adjust Balance slider to check left and right speaker channel separation.	No	Go to step 8.	\$(nodeText.noSymptomCode)	
	Play music with high and low tones to check bass and tweeter performance of left and right speakers.				
8.	Is sound from internal speakers audible, clear, and free of distortion?				
	Inspect and carefully clean affected speaker cone using a soft tissue to remove dust, debris, or foreign material such as metal fragments that easily adhere to the magnetic speaker. Reseat speaker connection and retest.	Yes	The issue was resolved by cleaning the affected speaker membrane. Verify resolution.	\$(nodeText.yesSymptomCode)	
	Is sound from affected speaker audible, clear, and free of distortion?	No	Go to step 9.	\$(nodeText.noSymptomCode)	
9.	To troubleshoot this issue completely, a known-good top case with keyboard and trackpad is required.	Yes	Go to step 10.	\$(nodeText.yesSymptomCode)	
		No	Speakers are part of top case.	K39	KEYBOARD
			Replace the top case assembly with keyboard and trackpad.		
9.	Do you have immediate access to a known-good top case with keyboard and trackpad?	No	Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.	K39	KEYBOARD
			Verify that the issue is resolved.		

	Check	Result	Action	Code	Commodity
10.	<p>Substitute a known-good top case with keyboard and trackpad and verify you can hear audio through internal speakers that is clear and free of distortion.</p> <p>Run AST 2 Audio Test suite to verify that left and right speakers produce expected audio test patterns from each speaker.</p> <p>Refer to TP587: Using Audio Test.</p> <p>Does the computer pass AST 2 Audio Test suite?</p>	Yes	<p>Speakers are part of top case.</p> <p>Replace the top case assembly with keyboard and trackpad.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K39	KEYBOARD
		No	<p>Reinstall the user's top case with keyboard and trackpad.</p> <p>Replace the logic board and power / Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M09	MLB

	Check	Result	Action	Code	Commodity
11.	<p>Connect and disconnect headphones/external speakers. Verify that audio can be played through both external and internal speakers, and that sound is clear and free of distortion.</p> <p>Run AST 2 Full System diagnostic suites (EFI & OS), if available, to ensure no other issues remain.</p> <p>Is the issue resolved?</p>	Yes	Issue resolved.	\$(nodeText.yesSymptomCode)	
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	

External Apple Bluetooth Peripherals

Unlikely causes:

There are no unlikely causes for this issue.

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none"> • Apple Bluetooth wireless keyboard, mouse, or trackpad is not recognized by known-good computer • Apple Bluetooth wireless keyboard, mouse, or trackpad will not pair with known-good computer • Apple Bluetooth wireless keyboard, mouse, or trackpad intermittently loses its connection • Apple wireless keyboard has one or more of the following issues: <ul style="list-style-type: none"> ◦ No power ◦ Battery will not charge (for peripherals with embedded batteries) ◦ Swollen battery (for peripherals with embedded batteries) ◦ Battery runtime too short ◦ Will not turn off ◦ One or more keys do not work ◦ Keys seem to stick, do not respond properly, or respond slowly ◦ Wrong keyboard language ◦ Keys missing or falling off ◦ Paint wearing off of one or more keys ◦ Physical and/or cosmetic issues • Apple wireless mouse has one or more of the following issues: <ul style="list-style-type: none"> ◦ No power ◦ Battery will not charge (for peripherals with embedded batteries) ◦ Swollen battery (for peripherals with embedded batteries) ◦ Battery runtime too short ◦ Will not turn off ◦ No mouse response ◦ Mouse click not recognized ◦ Mouse causes erratic cursor tracking ◦ Physical and/or cosmetic issues • Apple wireless trackpad has one or more of the following issues: <ul style="list-style-type: none"> ◦ No power ◦ Battery will not charge (for peripherals with embedded batteries) ◦ Swollen battery (for peripherals with embedded batteries) ◦ Battery runtime too short ◦ Will not turn off ◦ No trackpad response ◦ Trackpad click not recognized ◦ Trackpad causes erratic cursor tracking ◦ Trackpad requires high click force ◦ Trackpad click overly sensitive ◦ Force Touch or haptic feedback issue ◦ Physical and/or cosmetic issues <p>Note: Inform user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options.</p>	<p>Important: This troubleshooting procedure is intended only for Apple Bluetooth wireless peripheral devices, such as the following Apple products:</p> <ul style="list-style-type: none"> • Magic Mouse or Magic Mouse 2 • Magic Trackpad or Magic Trackpad 2 • Apple Wireless Keyboard or Magic Keyboard <p>For simplicity, this procedure refers to these products as wireless mouse, wireless trackpad, and wireless keyboard unless otherwise noted.</p> <p>For third-party devices, contact the manufacturer for support, software/firmware updates, or service options.</p> <ol style="list-style-type: none"> 1. Verify compatibility of the user's Apple wireless mouse, keyboard, or trackpad. Refer to HT201806: How to identify your Apple wireless mouse, keyboard, or trackpad. 2. Check for and apply the latest software and firmware updates. 3. In System Preferences, make sure Bluetooth is on and set to Discoverable. 4. For Apple Bluetooth peripherals with replaceable batteries, such as Magic Mouse, Magic Trackpad, or Apple Wireless Keyboard: If the device does not turn on, then install new or fully charged batteries. 5. For Apple Bluetooth peripherals with embedded batteries, such as Magic Mouse 2, Magic Trackpad 2, or Magic Keyboard: If the device does not turn on, then connect a known-good USB Power Adapter and Lightning cable to the device to charge it for at least two minutes. Switching the device on/off button or switch to the on position will allow the device to charge more quickly than when off. 6. For Apple Bluetooth peripherals with embedded batteries such as Magic Mouse 2, Magic Trackpad 2, or Magic Keyboard, verify that the computer being used with the peripheral supports Bluetooth 4.0 or later. Computers with earlier versions of Bluetooth support will not pair with Apple Bluetooth peripherals with embedded batteries. 7. Reset Bluetooth device or delete pairing (if applicable). 8. If Bluetooth pairs normally at your service location, then research potential sources of interference in the user's environment, such as microwave ovens or cordless phones in the 2.4/5GHz range. Refer to HT201542: Resolve Wi-Fi and Bluetooth issues caused by wireless interference. 9. Magic Mouse 2, Magic Trackpad 2, and Magic Keyboard can pair with the computer using either Bluetooth or a Lightning cable. If Bluetooth pairing is not possible due to interference or other reasons, then try pairing these products by connecting them to the known-good computer with a known-good Lightning cable. Refer to HT201178: Set up your Apple wireless mouse, keyboard, and trackpad. 10. For keyboard issues, refer to HT204540: If your Apple keyboard doesn't work and HT203162: One or more keys on the keyboard do not respond for troubleshooting tips.

Deep Dive

	Check	Result	Action	Code	Commodity
1.	<p>Visually inspect the user's wireless mouse, wireless trackpad, or wireless keyboard for any physical, cosmetic, and liquid damage.</p> <p>On a wireless mouse or wireless trackpad, verify that the mouse or trackpad button clicks.</p> <p>On keyboards, verify that all keyboard buttons are present and can be depressed normally.</p> <p>Does the user's wireless mouse, wireless trackpad, or wireless keyboard show signs of damage?</p>	Yes	Go to step 2.	\$(nodeText.yesSymptomCode)	
		No	Go to step 11.	\$(nodeText.noSymptomCode)	
2.	<p>Determine whether there is a safety issue, such as fumes, excessive heat, or shock.</p> <p>Do not perform procedures that can be a safety risk to you or the user.</p> <p>Can you proceed safely?</p>	Yes	Go to step 3.	\$(nodeText.yesSymptomCode)	
		No	<p>ESCALATION REQUIRED.</p> <p>Contact ACS for additional support regarding safety procedures for this product.</p>	\$(nodeText.noSymptomCode)	
3.	<p>Isolate damage issue to either user's wireless keyboard or wireless mouse or trackpad.</p> <p>Which peripheral is damaged?</p>	Wireless keyboard	Go to step 4.	\$(nodeText.yesSymptomCode)	
		Wireless mouse or trackpad	Go to step 8.	\$(nodeText.noSymptomCode)	
4.	<p>Closely examine the user's device to determine exact nature of the issue.</p> <p>Look for any signs of liquid spill, liquid penetration, or liquid damage to device.</p> <p>Is damage to user's device related to liquid spill?</p>	Yes	Replace the user's wireless keyboard out of warranty.	K90	KEYBOARD
		No	Go to step 5.	\$(nodeText.noSymptomCode)	
5.	<p>Closely examine the user's device for any signs of physical damage that may affect operation.</p> <p>Does the user's device exhibit this symptom?</p>	Yes	Replace the user's wireless keyboard out of warranty.	K16	KEYBOARD
		No	Go to step 6.	\$(nodeText.noSymptomCode)	
6.	<p>Closely examine the user's device for signs of paint wearing off of one or more keys.</p> <p>Does the user's device exhibit this symptom?</p>	Yes	Replace the user's wireless keyboard out of warranty.	K35	KEYBOARD
		No	Go to step 7.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
7.	Closely examine the user's device for any signs of cosmetic damage that does not affect operation.	Yes	Replace the user's wireless keyboard out of warranty.	K21	KEYBOARD
	Does the user's device exhibit this symptom?	No	Issue cannot be duplicated.	\$(nodeText.noSymptomCode)	
8.	Closely examine the user's device to determine exact nature of the issue.	Yes	Replace the user's wireless mouse or wireless trackpad out of warranty.	K90	MOUSE
	Look for any signs of liquid spill, liquid penetration, or liquid damage to device.	No	Go to step 9.	\$(nodeText.noSymptomCode)	
	Is damage to user's device related to liquid spill?				
9.	Closely examine the user's device for any signs of physical damage that may affect operation.	Yes	Replace the user's wireless mouse or wireless trackpad out of warranty.	K16	MOUSE
	Does the user's device exhibit this symptom?	No	Go to step 10.	\$(nodeText.noSymptomCode)	
10.	Closely examine the user's device for any signs of cosmetic damage that does not affect operation.	Yes	Replace the user's wireless mouse or wireless trackpad out of warranty.	K21	MOUSE
	Does the user's device exhibit this symptom?	No	Issue cannot be duplicated.	\$(nodeText.noSymptomCode)	
11.	Follow steps listed in HT201171: Using a Bluetooth mouse, keyboard, or trackpad with your Mac to pair the user's Bluetooth device with a known-good Mac.	Yes	ESCALATION REQUIRED. The Bluetooth device appears to be performing to specifications. There may be an issue with the user's computer, or wireless interference in user's environment. If issue persists, then contact ACS for additional support.	\$(nodeText.yesSymptomCode)	
	Test the user's wireless mouse, wireless trackpad, or wireless keyboard manually, using built-in applications on a known-good Mac. For example, use the Notes application to check the keys on a wireless keyboard.				
	Refer to HT204621: If your Apple wireless mouse, keyboard, or trackpad aren't working as expected for tips to resolve issues.				
12.	Does the user's wireless mouse, wireless trackpad, or wireless keyboard pair and function normally?	No	Go to step 12.	\$(nodeText.noSymptomCode)	
	Isolate failure to either user's wireless keyboard or wireless mouse or trackpad.	Wireless keyboard	Go to step 13.	\$(nodeText.yesSymptomCode)	
	Which peripheral is malfunctioning?	Wireless mouse or trackpad	Go to step 29.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
13.	Look for for any signs of power on the user's wireless keyboard, such as a power LED turning on. Note: Not all devices have a power LED.	Yes	Go to step 14.	\$(nodeText.yesSymptomCode)	
	Verify that the user's wireless keyboard turns ON when the on/off button or switch is placed in the on position. Verify that the user's wireless keyboard turns off when the on/off button or switch is placed in the off position. Does the user's wireless keyboard exhibit any power-related symptoms?	No	Go to step 18.	\$(nodeText.noSymptomCode)	
14.	Confirm that the issue with the user's wireless keyboard is: <ul style="list-style-type: none"> User's wireless keyboard is not functioning at all (seems dead, no power, power LED does not turn on) 	Yes	Replace the user's wireless keyboard. Verify that the issue is resolved.	K09	KEYBOARD
	Does the user's wireless keyboard exhibit this symptom?	No	Go to step 15.	\$(nodeText.noSymptomCode)	
15.	Verify that the user's wireless keyboard turns on when the on/off button or switch is placed in the on position. Confirm that the issue with the user's wireless keyboard is: <ul style="list-style-type: none"> On/off switch or button is defective 	Yes	Replace the user's wireless keyboard. Verify that the issue is resolved.	K19	KEYBOARD
	Does the user's wireless keyboard exhibit this symptom?	No	Go to step 16.	\$(nodeText.noSymptomCode)	
16.	Verify that the user's wireless keyboard turns off when the on/off button or switch is placed in the off position. Confirm that the issue with the user's wireless keyboard is: <ul style="list-style-type: none"> User's wireless keyboard remains on when the on/off button or switch has been placed in the off position 	Yes	Replace the user's wireless keyboard. Verify that the issue is resolved.	K34	KEYBOARD
	Does the user's wireless keyboard exhibit this symptom?	No	Go to step 17.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
17.	Verify if the user's wireless keyboard has any other power-related issue that is not related to the on/off button or switch.	Yes	Replace the user's wireless keyboard. Verify that the issue is resolved.	K20	KEYBOARD
	Confirm that the issue with the user's wireless keyboard is: <ul style="list-style-type: none"> Power Issue, not due to on/off button or switch Does the user's wireless keyboard exhibit this symptom?	No	Go to step 18.	\$(nodeText.noSymptomCode)	
18.	If the user's issue involves pairing or connecting to a Magic Keyboard, then you can connect to, pair, and use this device with the computer using either Bluetooth or a Lightning cable.	Yes	Go to step 19.	\$(nodeText.yesSymptomCode)	
	If Bluetooth pairing is not possible due to interference or other reasons, then try connecting the user's Magic Keyboard to the known-good computer with a known-good Lightning cable. For other Apple Bluetooth peripherals, select the "Yes" answer to continue. Does the user's Magic Keyboard connect and pair using USB?	No	Replace the user's wireless keyboard. Verify that the issue is resolved.	K30	KEYBOARD
19.	Verify that the known-good computer can recognize the user's wireless keyboard.	Yes	Replace the user's wireless keyboard. Verify that the issue is resolved.	K15	KEYBOARD
	Confirm that the issue with the user's wireless keyboard is: <ul style="list-style-type: none"> User's wireless keyboard is not recognized by known-good computer Does the user's wireless keyboard exhibit this symptom?	No	Go to step 20.	\$(nodeText.noSymptomCode)	
20.	Verify that the known-good computer can pair with the user's wireless keyboard using Bluetooth.	Yes	Replace the user's wireless keyboard. Verify that the issue is resolved.	K07	KEYBOARD
	Confirm that the issue with the user's wireless keyboard is: <ul style="list-style-type: none"> User's wireless keyboard cannot pair with a known-good computer Does the user's wireless keyboard exhibit this symptom?	No	Go to step 21.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
21.	Verify that the known-good computer maintains a Bluetooth connection to the user's wireless keyboard, and does not drop this connection.	Yes	Replace the user's wireless keyboard. Verify that the issue is resolved.	K08	KEYBOARD
	Confirm that the issue with the user's wireless keyboard is: <ul style="list-style-type: none"> User's wireless keyboard intermittently loses its connection with a known-good computer Does the user's wireless keyboard exhibit this symptom?	No	Go to step 22.	\$(nodeText.noSymptomCode)	
22.	Ask the user how often and how long the wireless keyboard is used.	Yes	Go to step 23.	\$(nodeText.yesSymptomCode)	
	Explain to the user that the battery issue could likely be caused by the user using the wireless keyboard continuously over a long period of time, rather than any fault of the wireless keyboard itself, macOS, or the user's computer. Gain agreement from the user that lengthy wireless keyboard usage is likely to be the cause of the battery life issue, and that there is no service issue with the wireless keyboard itself. Does the user agree that the battery life issue is likely caused by lengthy wireless keyboard usage?	No	Replace the user's wireless keyboard. Verify that the issue is resolved.	K32	KEYBOARD
23.	Attempt to charge the user's wireless keyboard battery for several more minutes. Verify that the user's wireless keyboard battery charge level that appears on the known-good computer that is paired with this user's wireless keyboard has increased and shows that the user's wireless keyboard is charging.	Yes	Replace the user's wireless keyboard. Verify that the issue is resolved.	K31	KEYBOARD
	Confirm that the issue with the user's wireless keyboard is: <ul style="list-style-type: none"> User's wireless keyboard battery will not charge Note: This symptom does not apply to peripherals with replaceable batteries. Does the user's wireless keyboard exhibit this symptom?	No	Go to step 24.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
24.	Closely inspect the user's wireless keyboard enclosure for signs of a swollen battery.	Yes	Replace the user's wireless keyboard.	K33	KEYBOARD
	Confirm that the issue with the user's wireless keyboard is: <ul style="list-style-type: none"> User's wireless keyboard battery appears swollen <p>Note: This symptom does not apply to peripherals with replaceable batteries.</p> <p>Does the user's wireless keyboard exhibit this symptom?</p>		Verify that the issue is resolved.		
		No	Go to step 25.	\$(nodeText.noSymptomCode)	
25.	Verify that each and every wireless keyboard key functions as expected when pressed and released.	Yes	Replace the user's wireless keyboard.	K01	KEYBOARD
	Confirm that the issue with the user's wireless keyboard is: <ul style="list-style-type: none"> One or more keys do not work <p>Does the user's wireless keyboard exhibit this symptom?</p>		Verify that the issue is resolved.		
		No	Go to step 26.	\$(nodeText.noSymptomCode)	
26.	Verify that each and every wireless keyboard key functions as expected when pressed and released.	Yes	Replace the user's wireless keyboard.	K05	KEYBOARD
	Confirm that the issue with the user's wireless keyboard is: <ul style="list-style-type: none"> Keys seem to stick, do not respond properly, or respond slowly <p>Does the user's wireless keyboard exhibit this symptom?</p>		Verify that the issue is resolved.		
		No	Go to step 27.	\$(nodeText.noSymptomCode)	
27.	Verify that each and every wireless keyboard key is intact and not missing.	Yes	Replace the user's wireless keyboard.	K27	KEYBOARD
	Confirm that the issue with the user's wireless keyboard is: <ul style="list-style-type: none"> Keys missing or falling off <p>Does the user's wireless keyboard exhibit this symptom?</p>		Verify that the issue is resolved.		
		No	Go to step 28.	\$(nodeText.noSymptomCode)	
28.	Verify that the wireless keyboard language is as expected.	Yes	Replace the user's wireless keyboard.	K04	KEYBOARD
	Confirm that the issue with the user's wireless keyboard is: <ul style="list-style-type: none"> Wrong keyboard language version <p>Does the user's wireless keyboard exhibit this symptom?</p>		Verify that the issue is resolved.		
		No	Issue cannot be duplicated.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
29.	Look for for any signs of power on the user's wireless mouse or trackpad, such as a power LED turning on. Note: Not all devices have a power LED.	Yes	Go to step 30.	\${nodeText.yesSymptomCode}	
	Verify that the user's wireless mouse or trackpad turns on when the on/off button or switch is placed in the on position.	No	Go to step 34.	\${nodeText.noSymptomCode}	
	Verify that the user's wireless mouse or trackpad turns off when the on/off button or switch is placed in the off position.				
	Does the user's wireless mouse or trackpad exhibit any power-related symptoms?				
30.	Confirm that the issue with the user's wireless mouse or trackpad is:	Yes	Replace the user's wireless mouse or trackpad.	K09	MOUSE
	<ul style="list-style-type: none"> User's wireless mouse or trackpad is not functioning at all (seems dead, no power, power LED does not turn on) 		Verify that the issue is resolved.		
	Does the user's wireless mouse or trackpad exhibit this symptom?	No	Go to step 31.	\${nodeText.noSymptomCode}	
31.	Verify that the user's wireless mouse or trackpad turns on when the on/off button or switch is placed in the on position.	Yes	Replace the user's wireless mouse or trackpad.	K19	MOUSE
	Confirm that the issue with the user's wireless mouse or trackpad is:		Verify that the issue is resolved.		
	<ul style="list-style-type: none"> on/off switch or button is defective 	No	Go to step 32.	\${nodeText.noSymptomCode}	
	Does the user's wireless mouse or trackpad exhibit this symptom?				
32.	Verify that the user's wireless mouse or trackpad turns off when the on/off button or switch is placed in the off position.	Yes	Replace the user's wireless mouse or trackpad.	K34	MOUSE
	Confirm that the issue with the user's wireless mouse or trackpad is:		Verify that the issue is resolved.		
	<ul style="list-style-type: none"> User's wireless mouse or trackpad remains on when the on/off button or switch has been placed in the off position 	No	Go to step 33.	\${nodeText.noSymptomCode}	
	Does the user's wireless mouse or trackpad exhibit this symptom?				

	Check	Result	Action	Code	Commodity
33.	Verify if the user's wireless mouse or trackpad has any other power-related issue that is not related to the on/off button or switch.	Yes	Replace the user's wireless mouse or trackpad. Verify that the issue is resolved.	K20	MOUSE
	Confirm that the issue with the user's wireless mouse or trackpad is: <ul style="list-style-type: none"> Power Issue, not due to on/off button or switch Does the user's wireless mouse or trackpad exhibit this symptom?	No	Go to step 34.	\$(nodeText.noSymptomCode)	
34.	If the user's issue involves pairing or connecting to a Magic Mouse 2 or Magic Trackpad 2, then you can connect to and pair these devices with a computer using either Bluetooth or a Lightning cable. If Bluetooth pairing is not possible due to interference or other reasons, then try connecting the user's Magic Mouse 2 or Magic Trackpad 2 to a known-good computer with a known-good Lightning cable. For other Apple Bluetooth peripherals, select the "Yes" answer to continue. Does the user's Magic Mouse 2 or Magic Trackpad 2 connect and pair using USB?	Yes	Go to step 35.	\$(nodeText.yesSymptomCode)	
		No	Replace the user's wireless mouse or trackpad. Verify that the issue is resolved.	K30	MOUSE
35.	Verify that the known-good computer can recognize the user's wireless mouse or trackpad. Confirm that the issue with the user's wireless mouse or trackpad is: <ul style="list-style-type: none"> User's wireless mouse or trackpad is not recognized by known-good computer. Does the user's wireless mouse or trackpad exhibit this symptom?	Yes	Replace the user's wireless mouse or trackpad. Verify that the issue is resolved.	K15	MOUSE
		No	Go to step 36.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
36.	Verify that the known-good computer can pair with the user's wireless mouse or trackpad.	Yes	Replace the user's wireless mouse or trackpad. Verify that the issue is resolved.	K07	MOUSE
	Confirm that the issue with the user's wireless mouse or trackpad is: <ul style="list-style-type: none"> User's wireless mouse or trackpad cannot pair with a known-good computer Does the user's wireless mouse or trackpad exhibit this symptom?	No	Go to step 37.	\$(nodeText.noSymptomCode)	
37.	Verify that the known-good computer maintains a Bluetooth connection to the user's wireless mouse or trackpad, and does not drop this connection.	Yes	Replace the user's wireless mouse or trackpad. Verify that the issue is resolved.	K08	MOUSE
	Confirm that the issue with the user's wireless mouse or trackpad is: <ul style="list-style-type: none"> User's wireless mouse or trackpad intermittently loses its connection with a known-good computer Does the user's wireless mouse or trackpad exhibit this symptom?	No	Go to step 38.	\$(nodeText.noSymptomCode)	
38.	Ask the user how often and how long the wireless mouse or trackpad is used.	Yes	Go to step 39.	\$(nodeText.yesSymptomCode)	
	Gain agreement from the user that lengthy wireless mouse or trackpad usage is likely to be the cause of the battery life issue, and that there is no service issue with the wireless mouse or trackpad itself. Does the user agree that the battery life issue is likely caused by lengthy wireless device usage?	No	Replace the user's wireless mouse or trackpad. Verify that the issue is resolved.	K32	MOUSE

	Check	Result	Action	Code	Commodity
39.	Attempt to charge the user's wireless mouse or trackpad battery for several more minutes. Verify that the user's wireless mouse or trackpad battery charge level that appears on the known-good computer that is paired with this user's wireless mouse or trackpad has increased and shows that the user's wireless mouse or trackpad is charging.	Yes	Replace the user's wireless mouse or trackpad. Verify that the issue is resolved.	K31	MOUSE
	Confirm that the issue with the user's wireless mouse or trackpad is: <ul style="list-style-type: none"> User's wireless mouse or trackpad battery will not charge Note: This symptom does not apply to peripherals with replaceable batteries. Does the user's wireless mouse or trackpad exhibit this symptom?	No	Go to step 40.	\$(nodeText.noSymptomCode)	
40.	Closely inspect the user's wireless mouse or trackpad enclosure for signs of a swollen battery.	Yes	Replace the user's wireless mouse or trackpad. Verify that the issue is resolved.	K33	MOUSE
	Confirm that the issue with the user's wireless mouse or trackpad is: <ul style="list-style-type: none"> User's wireless mouse or trackpad battery appears swollen Note: This symptom does not apply to peripherals with replaceable batteries. Does the user's wireless mouse or trackpad exhibit this symptom?	No	Go to step 41.	\$(nodeText.noSymptomCode)	
41.	Isolate failure to either user's wireless mouse or wireless trackpad.	Wireless mouse	Go to step 42.	\$(nodeText.yesSymptomCode)	
	Which peripheral is malfunctioning?	Wireless trackpad	Go to step 45.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
42.	Verify that the overall function of the user's wireless mouse performs as expected when used with the known-good computer.	Yes	Replace the user's wireless mouse. Verify that the issue is resolved.	K26	MOUSE
	Confirm that the issue with the user's wireless mouse is: <ul style="list-style-type: none"> No mouse response Does the user's wireless mouse exhibit this symptom?	No	Go to step 43.	\$(nodeText.noSymptomCode)	
43.	Verify that the clicking function of the user's wireless mouse performs as expected when pressed and released.	Yes	Replace the user's wireless mouse. Verify that the issue is resolved.	K14	MOUSE
	Confirm that the issue with the user's wireless mouse is: <ul style="list-style-type: none"> Mouse clicking function not working properly Does the user's wireless mouse exhibit this symptom?	No	Go to step 44.	\$(nodeText.noSymptomCode)	
44.	Verify that the touch gesture function of the user's wireless mouse performs as expected when the mouse surface is touched.	Yes	Replace the user's wireless mouse. Verify that the issue is resolved.	K18	MOUSE
	Confirm that the issue with the user's wireless mouse is: <ul style="list-style-type: none"> Touch/Multi-Touch gesture issue Does the user's wireless mouse exhibit this symptom?	No	Issue cannot be duplicated.	\$(nodeText.noSymptomCode)	
45.	Verify that the overall function of the user's wireless trackpad performs as expected when used with the known-good computer.	Yes	Replace the user's wireless trackpad. Verify that the issue is resolved.	K23	MOUSE
	Confirm that the issue with the user's wireless trackpad is: <ul style="list-style-type: none"> Trackpad cursor not responding Does the user's wireless trackpad exhibit this symptom?	No	Go to step 46.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
46.	Verify that the user's wireless trackpad exhibits smooth continuous tracking when used with the known-good computer, and does not skip or behave erratically.	Yes	Replace the user's wireless trackpad. Verify that the issue is resolved.	K12	MOUSE
	Confirm that the issue with the user's wireless trackpad is: <ul style="list-style-type: none"> Trackpad cursor not tracking properly Does the user's wireless trackpad exhibit this symptom?	No	Go to step 47.	\$(nodeText.noSymptomCode)	
47.	Verify that the clicking function of the user's wireless trackpad performs as expected when pressed and released, and that the click is recognized by the known-good computer.	Yes	Replace the user's wireless trackpad. Verify that the issue is resolved.	K13	MOUSE
	Confirm that the issue with the user's wireless trackpad is: <ul style="list-style-type: none"> Trackpad click not recognized Does the user's wireless trackpad exhibit this symptom?	No	Go to step 48.	\$(nodeText.noSymptomCode)	
48.	Verify that the user's wireless trackpad clicking function does not require excessive force when pressed and released.	Yes	Replace the user's wireless trackpad. Verify that the issue is resolved.	K24	MOUSE
	Confirm that the issue with the user's wireless trackpad is: <ul style="list-style-type: none"> Trackpad requires high click force Does the user's wireless trackpad exhibit this symptom?	No	Go to step 49.	\$(nodeText.noSymptomCode)	
49.	Verify that the user's wireless trackpad clicking function is not overly sensitive to clicking when pressed and released.	Yes	Replace the user's wireless trackpad. Verify that the issue is resolved.	K25	MOUSE
	Confirm that the issue with the user's wireless trackpad is: <ul style="list-style-type: none"> Trackpad click oversensitive Does the user's wireless trackpad exhibit this symptom?	No	Go to step 50.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
50.	Verify that the user's wireless trackpad Force Touch function performs as expected and that haptic feedback is felt in response. Note: This feature does not apply to all models.	Yes	Replace the user's wireless trackpad. Verify that the issue is resolved.	K29	MOUSE
	Confirm that the issue with the user's wireless trackpad is: <ul style="list-style-type: none"> Trackpad Force Touch or haptic feedback issue 	No	Issue cannot be duplicated.	<code> \${nodeText.noSymptomCode} </code>	
	Does the user's wireless trackpad exhibit this symptom?				

External Apple Wired Keyboard and Mouse

Unlikely causes:

There are no unlikely causes for this issue.

Quick Check

Symptoms	Quick Check
<p>Apple wired USB keyboard or mouse does not function with user's computer or shows one or more of the following symptoms:</p> <ul style="list-style-type: none">• One or more mouse buttons do not click• Mouse scroll ball does not operate smoothly• No mouse response• Keys stick• Keys loose or missing• One or more keys do not respond when pressed• No keyboard response at all• Apple wired mouse causes erratic cursor tracking• Apple wired keyboard or mouse is not recognized• Apple wired keyboard or mouse has physical damage that affects operation• Paint wearing off of one or more keys• Apple wired keyboard or mouse has cosmetic damage that does not affect operation <p>Note: Inform user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options.</p>	<ol style="list-style-type: none">1. Disconnect all USB devices from the user's computer except for the user's mouse or keyboard. Troubleshoot only one device at a time to help isolate the issue.2. Unplug the keyboard or mouse from the USB port, wait a few seconds, and reconnect it.3. Connect the keyboard or mouse to another USB port on the user's computer.4. Make sure the USB connectors are plugged in completely and correctly.5. Visually inspect the USB connectors and ports for damage or debris.6. Try operating the user's mouse on another surface. Ask the user about the type of surface usually being used with the mouse. Glossy or transparent surfaces, or those with repetitive patterns, may cause mouse-tracking errors or faulty mouse operation. Explain that solid, nonreflective, opaque surfaces work best. The surface should be clean, but not shiny.7. Visually inspect the user's keyboard or mouse for dirt, hair, liquid damage, or other debris. Check to see if the user has pets. Pet hair can lie across the laser and cause intermittent mouse issues. Refer to HT204172: How to clean your Apple products for information on cleaning the user's keyboard or mouse.8. Connect the user's USB keyboard or mouse to an available USB port on a known-good computer to determine if the issue is related to the USB port on the user's computer, or to the user's USB keyboard or mouse. If the user's keyboard or mouse functions when used with the known-good computer, go to the "USB Port Not Recognized" troubleshooting flow.9. For keyboard issues, refer to HT204540: If your Apple keyboard doesn't work and HT203162: One or more keys on the keyboard do not respond for troubleshooting tips.

Deep Dive

	Check	Result	Action	Code	Commodity
1.	<p>Visually inspect the user's USB mouse or keyboard to verify that the attached USB cable and connector are not damaged or frayed.</p> <p>Check user's keyboard or mouse for physical and liquid damage.</p> <p>On mice, verify that all mouse buttons click and laser tracking LED illuminates.</p> <p>On keyboards, verify that all keys are present and can be depressed normally.</p> <p>Does the user's USB mouse or keyboard, or its attached cable or connector, show signs of damage?</p>	Yes	Go to step 2.	`\${nodeText.yesSymptomCode}`	
		No	Go to step 12.	`\${nodeText.noSymptomCode}`	
2.	<p>Isolate damage issue to either user's wired USB keyboard or mouse.</p> <p>Which peripheral is damaged?</p>	USB Keyboard	Go to step 3.	`\${nodeText.yesSymptomCode}`	
		USB Mouse	Go to step 9.	`\${nodeText.noSymptomCode}`	
3.	<p>Closely examine user's keyboard to determine exact nature of the issue.</p> <p>Look for any signs of liquid spill, liquid penetration, and liquid damage to keyboard.</p> <p>Is damage to user's keyboard related to liquid spill?</p>	Yes	<p>Replace USB keyboard. Verify issue resolved.</p> <p>Note: Inform user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options.</p>	K90	KEYBOARD
		No	Go to step 4.	`\${nodeText.noSymptomCode}`	
4.	<p>Click each key to ensure no keys are sticking in the down or up position.</p> <p>Is damage to user's keyboard related to sticky keys or slow key response?</p>	Yes	<p>Replace USB keyboard. Verify issue resolved.</p> <p>Note: Inform user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options.</p>	K05	KEYBOARD
		No	Go to step 5.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
5.	Look for any loose or missing keycaps. Is damage to user's keyboard related to loose or missing keycaps?	Yes	Replace USB keyboard. Verify issue resolved. Note: Inform user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options.	K27	KEYBOARD
		No	Go to step 6.	\${nodeText.noSymptomCode}	
6.	Closely inspect the keyboard for any signs of physical damage that may affect operation. Does the user's keyboard exhibit this symptom?	Yes	Replace USB keyboard. Verify issue resolved. Note: Inform user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options.	K16	KEYBOARD
		No	Go to Step 7.	\${nodeText.noSymptomCode}	
7.	Closely examine the keyboard for signs of paint wearing off of one or more keys. Does the user's keyboard exhibit this symptom?	Yes	Replace USB keyboard. Verify issue resolved. Note: Inform user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options.	K35	KEYBOARD
		No	Go to step 8.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
8.	<p>Closely inspect the keyboard for any signs of cosmetic damage that does not affect operation.</p> <p>Does the user's keyboard exhibit this symptom?</p>	Yes	<p>Replace USB keyboard. Verify issue resolved.</p> <p>Note: Inform user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options.</p>	K21	KEYBOARD
		No	Issue cannot be duplicated.	<p> <code> \${nodeText.noSymptomCode} </code> </p>	
9.	<p>Closely examine user's mouse to determine exact nature of the issue.</p> <p>Look for any signs of liquid spill, liquid penetration, and liquid damage to mouse.</p> <p>Is damage to user's mouse related to liquid spill?</p>	Yes	<p>Replace USB mouse. Verify issue resolved.</p> <p>Note: Inform user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options.</p>	K90	MOUSE
		No	Go to step 10.	<p> <code> \${nodeText.noSymptomCode} </code> </p>	
10.	<p>Closely inspect the mouse for any signs of physical damage that may affect operation.</p> <p>Is there physical damage to user's mouse?</p>	Yes	<p>Replace USB mouse. Verify issue resolved.</p> <p>Note: Inform user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options.</p>	K16	MOUSE
		No	Go to step 11.	<p> <code> \${nodeText.noSymptomCode} </code> </p>	

	Check	Result	Action	Code	Commodity
11.	Closely inspect the mouse for any signs of cosmetic damage that does not affect operation.	Yes	Replace USB mouse. Verify issue resolved. Note: Inform user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options.	K21	MOUSE
	Is there cosmetic damage to user's mouse?	No	Issue cannot be duplicated.	\${nodeText.noSymptomCode}	
12.	Isolate failure issue to either user's wired USB keyboard or mouse.	USB Keyboard	Go to step 17.	\${nodeText.yesSymptomCode}	
	Which peripheral is malfunctioning?	USB Mouse	Go to step 13.	\${nodeText.noSymptomCode}	
13.	Connect user's USB mouse to a free USB port on a known-good computer, and check System Information to determine whether the computer recognizes the mouse.	Yes	Go to step 14.	\${nodeText.yesSymptomCode}	
	Is mouse recognized by a known-good computer?	No	Replace USB mouse. Verify issue resolved.	K15	MOUSE
14.	Move the mouse and verify that the cursor on the known-good computer screen moves smoothly.	Yes	Replace USB mouse. Verify issue resolved.	K26	MOUSE
	Is issue related to mouse function?	No	Go to step 15.	\${nodeText.noSymptomCode}	
15.	Click and roll the mouse's scroll ball to check that it rolls freely in all directions and with no physical resistance.	Yes	Replace USB mouse. Verify issue resolved.	K06	MOUSE
	Is issue related to the scroll ball?	No	Go to step 16.	\${nodeText.noSymptomCode}	
16.	Press the mouse's various buttons to verify that they click properly, without sticking, every time they are pressed.	Yes	Replace USB mouse. Verify issue resolved.	K14	MOUSE
	Is issue related to the mouse button(s)?	No	Issue cannot be duplicated.	\${nodeText.noSymptomCode}	
17.	Connect user's USB keyboard to a free USB port on a known-good computer, and check System Information to determine whether the computer recognizes the keyboard.	Yes	Go to step 18.	\${nodeText.yesSymptomCode}	
	Is keyboard recognized by a known-good computer?	No	Replace USB keyboard. Verify issue resolved.	K15	KEYBOARD

	Check	Result	Action	Code	Commodity
18.	Verify that all keys functions as expected when pressed and released.	Yes	Replace USB keyboard. Verify issue resolved.	K01	KEYBOARD
	Is issue related to specific keys not working?	No	Go to step 19.	\${nodeText.noSymptomCode}	
19.	Verify that the keyboard language is as expected.	Yes	Replace USB keyboard. Verify issue resolved.	K04	KEYBOARD
	Is issue related to keyboard language?	No	Issue cannot be duplicated.	\${nodeText.noSymptomCode}	

Internal Microphone Issues

Unlikely causes:

Bottom case, Display assembly, AC Wall adapter (duckhead), eDP flex cable, Fan, Keyboard flex cable, Touch ID board, I/O board, Power adapter, Power cord, USB-C charging cable, Vent/antenna module

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">• Microphone not working, but audio output is functional.• Microphone audio is garbled.• Internal microphone input cannot be selected. <p>Note: Inform the user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover and disconnected the battery.</p> <ol style="list-style-type: none">1. Go to System Preferences > Sound, and verify the following: Input tab:<ul style="list-style-type: none">• Internal Microphone is available and selected for sound input.• “Input volume” slider is not set to zero. Output tab:<ul style="list-style-type: none">• Internal Speakers is available and selected for sound output.• “Output volume” is not muted or set to zero.2. Go to System Preferences > Sound > Input tab, and verify that the “Input level” indicator moves when speaking into the microphone.3. Check that no cables are inserted into the headphone jack. Use an otoscope to visually inspect jack. Use compressed air to clean and remove any debris.4. Reset the NVRAM using the procedure for this computer in HT204063: Reset NVRAM or PRAM on your Mac.5. Refer to HT201260: Find out which macOS your Mac is using to check that the system build is correct for this computer model.6. Check for and apply the latest software and firmware updates.

Deep Dive

	Check	Result	Action	Code	Commodity
1.	Follow steps in Apple Configurator 2 User Guide to restore the T2 firmware on the user’s computer.	Yes	Go to step 2.	`\${nodeText.yesSymptomCode}`	
	Restart the computer and verify that it completely starts up to macOS. Retest by going to System Preferences > Sound > Input tab, and verifying that the input level indicator moves when speaking into the microphone. Does the issue persist after restoring T2 firmware?	No	The issue was resolved by restoring T2 firmware.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
2.	Disconnect any connected headphones or external speakers. Go to System Preferences > Sound > Input tab and verify that Internal Microphone is available and selected for sound input. Does System Preferences list “External Microphone” instead?	Yes	Go to step 3.	`\${nodeText.yesSymptomCode}`	
		No	Go to step 4.	`\${nodeText.noSymptomCode}`	
3.	Debris in, or damage to, the headphone jack can cause the computer to become stuck in External Microphone input mode. Use a lighted otoscope or magnifying glass to inspect for damage or debris inside the jack. Use compressed air to clean and remove any debris. Is there any damage to the headphone jack?	Yes	Replace the audio board. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair. Verify that the issue is resolved.	M24	OTHER BOARD
		No	Go to step 4.	`\${nodeText.noSymptomCode}`	
4.	Run AST 2 Audio Test suite to verify that built-in microphone detects expected audio test patterns produced from each speaker. Refer to TP587: Using Audio Test Does the computer pass AST 2 Audio Test suite?	Yes	ESCALATION REQUIRED. Contact CSS for additional support or a multipart repair.	X99	
		No	Go to step 5.	`\${nodeText.noSymptomCode}`	
5.	Follow Service Guide procedures to remove the bottom case and disconnect the battery from the logic board. Disconnect the microphone flex cable from the logic board. Inspect the cable and connectors on the logic board and microphone flex cable for any damage. Is there any damage to the microphone flex cable or connectors?	Yes	Go to step 6.	`\${nodeText.yesSymptomCode}`	
		No	Go to step 7.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
6.	<p>Determine whether there is damage to the microphone flex cable, the logic board, or to a combination of multiple components.</p> <p>Is the damage limited to the microphone flex cable only?</p>	Yes	<p>Microphone is part of top case.</p> <p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K16	KEYBOARD
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	
7.	<p>Reconnect the microphone flex cable to the logic board, verifying that the connectors are all seated properly.</p> <p>Retest by going to System Preferences > Sound > Input tab, and verifying that the input level indicator moves when speaking into the microphone.</p> <p>Is the microphone recognized and functional?</p>	Yes	Go to step 8.	<p>\${nodeText.yesSymptomCode}</p>	
		No	Go to step 9.	<p>\${nodeText.noSymptomCode}</p>	

	Check	Result	Action	Code	Commodity
8.	<p>Run AST 2 Audio Test suite to verify that built-in microphone detects expected audio test patterns produced from each speaker.</p> <p>Refer to TP587: Using Audio Test</p> <p>Does the computer pass AST 2 Audio Test suite?</p>	Yes	<p>The issue was resolved by reseating the microphone flex cable.</p> <p>Run AST 2 Trackpad Calibration Check suite to verify the proper functionality of the trackpad, as well as recalibrate it if necessary.</p> <p>Refer to TP1314: Trackpad Calibration Check for instructions.</p> <p>Verify that the issue is resolved.</p>	\${nodeText.yesSymptomCode}	
		No	Go to step 9.		
9.	<p>Troubleshooting this issue completely requires a known-good top case assembly.</p> <p>Do you have immediate access to a known-good top case assembly?</p>	Yes	Go to step 10.	\${nodeText.yesSymptomCode}	
		No	<p>Microphone is part of top case.</p> <p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>		KEYBOARD

	Check	Result	Action	Code	Commodity
10.	<p>Substitute a known-good top case assembly.</p> <p>Retest by going to System Preferences > Sound > Input tab, and verifying that the input level indicator moves when speaking into the microphone.</p>	Yes	<p>Microphone is part of top case.</p> <p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K36	KEYBOARD
	<p>Run AST 2 Audio Test suite to verify that built-in microphone detects expected audio test patterns produced from each speaker.</p> <p>Refer to TP587: Using Audio Test</p> <p>Does the computer pass AST 2 Audio Test suite?</p>	No	<p>Reinstall the user's top case.</p> <p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M09	MLB

	Check	Result	Action	Code	Commodity
11.	Verify that the internal microphone is available, selected, and functional, and that the input level indicator moves when speaking into the microphone. Then record a sample audio file and play it back to verify that it is free of distortion.	Yes	The issue is resolved. Verify resolution.	\${nodeText.yesSymptomCode}	
	<p>Run AST 2 Full System diagnostic suites (EFI & OS), if available, to ensure no other issues remain.</p> <p>Verify that the issue is resolved.</p> <p>Is the issue resolved?</p>	No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	

No Audio from Internal Speakers or Headphone Jack

Unlikely causes:

Bottom case, display assembly, duckhead, eDP flex cable, fans, keyboard flex cable, I/O boards, audio board, power adapter, USB-C charging cable, vent/antenna module

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">No sound from headphone jackNo sound from left or right speakers <p>Note: Inform the user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw.</p> <ol style="list-style-type: none">Use controls to increase the sound volume to medium, halfway between minimum and maximum setting.In System Preferences > Sound > Output, verify “Internal Speaker” output is available and selected.Connect headphones or external speakers to the headphone jack. In System Preferences > Sound > Output, verify whether the Internal Speakers setting switches to Headphones, and whether audio can be played on headphones or external speakers.Disconnect any device connected to the headphone jack. In System Preferences > Sound > Output, check that the sound output device reverts to Internal Speakers and that the Balance slider is set halfway between left and right.Reset the NVRAM using the procedure for this computer in HT204063: Reset NVRAM or PRAM on your Mac.Test the audio output using more than one application or website.Refer to HT201260: Find out which macOS your Mac is using to check that the system build is correct for this computer model.Check for and apply the latest software and firmware updates.

Deep Dive

	Check	Result	Action	Code	Commodity
1.	Follow steps in Restore Apple T2 firmware on 2018 MacBook Pro to restore the T2 firmware on the user’s computer.	Yes	Go to step 2.	`\${nodeText.yesSymptomCode}`	
	Restart the computer and verify that it completely starts up to macOS. Retest for speaker or headphone jack audio issue. Does the issue persist after restoring T2 firmware?	No	The issue was resolved by restoring T2 firmware.	`\${nodeText.noSymptomCode}`	
2.	Disconnect any connected headphones or external speakers. Go to System Preferences > Sound > Output tab and verify that Internal Speaker is available and selected for sound output.	Yes	Go to step 3.	`\${nodeText.yesSymptomCode}`	
	Does System Preferences list “Headphones” instead?	No	Go to step 4.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
3.	<p>Debris in, or damage to, the headphone jack can cause the computer to become stuck in Headphone or External Speaker mode.</p> <p>Use a lighted otoscope or magnifying glass to inspect for damage or debris inside the jack.</p> <p>Use compressed air to clean and remove any debris.</p> <p>Is there any damage to the headphone jack?</p>	Yes	<p>Replace the audio board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M24	OTHER BOARD
		No	Go to step 4.	\${nodeText.noSymptomCode}	
4.	<p>Run AST 2 Audio Test suite to verify that left and right speakers produce expected audio test patterns from each speaker.</p> <p>Refer to TP587: Using Audio Test</p> <p>Does the computer pass AST 2 Audio Test suite?</p>	Yes	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	
		No	Go to step 5.	\${nodeText.noSymptomCode}	
5.	<p>Follow Service Guide procedures to remove the bottom case and disconnect the battery from the logic board.</p> <p>Disconnect the audio flex cable from the logic board. Inspect the cable and connectors on the logic board and audio flex cable for any damage.</p> <p>Is there any damage to the flex cable or connectors?</p>	Yes	Go to step 6.	\${nodeText.yesSymptomCode}	
		No	Go to step 7.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
6.	<p>Determine whether the damage is located on the audio flex cable, the logic board, or a combination of multiple components.</p> <p>Is the damage limited to the audio flex cable only?</p>	Yes	<p>Replace the audio board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M24	OTHER BOARD
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	
7.	<p>Reconnect the audio flex cable to the logic board, verifying that the connectors are all seated properly.</p> <p>Test the audio output from internal speakers and headphone jack using known-good headphones or external speakers.</p> <p>Can you hear audio through the internal speakers?</p>	Yes	Go to step 8.	\${nodeText.yesSymptomCode}	
		No	Go to step 9.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
8.	<p>Run AST 2 Audio Test suite to verify that left and right speakers produce expected audio test patterns from each speaker.</p> <p>Refer to TP587: Using Audio Test</p> <p>Does the computer pass AST 2 Audio Test suite?</p>	Yes	<p>The issue was resolved by reseating the audio flex cable.</p> <p>Run AST 2 Trackpad Calibration Check suite to verify the proper functionality of the trackpad, as well as recalibrate it if necessary.</p> <p>Refer to TP1314: Trackpad Calibration Check for instructions.</p> <p>Verify that the issue is resolved.</p>	{nodeText.yesSymptomCode}	
		No	Go to step 9.		
				{nodeText.noSymptomCode}	
9.	<p>Connect known-good headphones or external speakers to test the output from the headphone jack. Verify you can hear audio.</p> <p>Can you hear audio through the headphones or external speakers?</p>	Yes	Go to step 10.	{nodeText.yesSymptomCode}	
		No	<p>Replace the audio board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M09	OTHER BOARD

	Check	Result	Action	Code	Commodity
10.	<p>Follow Service Guide procedures to remove the bottom case and disconnect the battery from the logic board.</p> <p>Locate speaker connections on logic board. Disconnect and inspect both speaker cable connectors and corresponding connectors on logic board for damage.</p> <p>Reconnect the left and right speakers to the logic board, verifying that the connections are all seated properly.</p> <p>Did you find damage to speakers or logic board connector?</p>	Yes	Go to step 11.	\${nodeText.yesSymptomCode}	
		No	Go to step 12.	\${nodeText.noSymptomCode}	
11.	<p>Determine whether damage is on the logic board, speakers, or both.</p> <p>Is the damage limited to speakers?</p>	Yes	<p>Replace the top case assembly with keyboard and trackpad.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K38	KEYBOARD
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	

	Check	Result	Action	Code	Commodity
12.	With speaker connectors reseated to logic board, verify you can hear audio through internal speakers.	Yes	The issue was resolved by reseating cables. Verify resolution.	#{nodeText.yesSymptomCode}	
	In System Preferences > Sound > Output tab, adjust Balance slider to check left and right speaker channel separation.	No	Go to step 13.	#{nodeText.noSymptomCode}	
	Play music with high and low tones to check bass and tweeter performance of left and right speakers.				
	Do internal speakers present full range of expected audio performance?				
13.	To troubleshoot this issue completely, a known-good top case with keyboard and trackpad is required.	Yes	Go to step 14.	#{nodeText.yesSymptomCode}	
		No	Replace the top case assembly with keyboard and trackpad.	K38	KEYBOARD
			Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.		
	Do you have immediate access to a known-good top case with keyboard and trackpad?		Verify that the issue is resolved.		

	Check	Result	Action	Code	Commodity
14.	<p>Substitute a known-good top case with keyboard and trackpad and verify you can hear audio through internal speakers.</p> <p>Run AST 2 Audio Test suite to verify that left and right speakers produce expected audio test patterns from each speaker.</p> <p>Refer to TP587: Using Audio Test</p> <p>Does the computer pass AST 2 Audio Test suite?</p>	Yes	<p>Replace the top case assembly with keyboard and trackpad.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K38	KEYBOARD
		No	<p>Reinstall the user's top case with keyboard and trackpad.</p> <p>Replace the logic board and power / Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M09	MLB

	Check	Result	Action	Code	Commodity
15.	Connect and disconnect headphones/external speakers. Verify that audio can be played through both external and internal speakers, and that sound is clear and free of distortion. Run AST 2 Full System diagnostic suites (EFI & OS), if available, to ensure no other issues remain. Is the issue resolved?	Yes	The issue is resolved. Verify resolution.	\${nodeText.yesSymptomCode}	
		No	ESCALATION REQUIRED. Contact CSS for additional support or a multipart repair.	X99	

No Audio to External Display Speakers

Unlikely causes:

Bottom case, display assembly, duckhead, eDP flex cable, fans, keyboard flex cable, Touch ID board, audio board, power adapter, USB-C charging cable, vent/antenna module.

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">Video but no audio to external display; audio works on internal speakers <p>Note: Inform the user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw.</p> <ol style="list-style-type: none">Gather display type and model information from the user.Always use a known-good USB-C Digital AV Multiport Adapter and known-good HDMI display equipped with internal speakers to verify the issue.In System Preferences > Sound > Output, select the available DisplayPort, Thunderbolt, HDMI, or USB device for sound output. (The output name varies depending on the display model.)On the HDMI display, verify that the correct input has been selected.Connect the video adapter to each USB-C connector on the computer and retest each time to isolate a possible faulty USB-C port on the user's computer.Test the audio output using more than one application or website.Reset the NVRAM using the procedure for this computer in HT204063: Reset NVRAM or PRAM on your Mac.Reset the SMC using the procedure for this computer in HT201295: How to reset the System Management Controller (SMC) on your Mac.Refer to HT201260: Find out which macOS your Mac is using to check that the system build is correct for this computer model.With the user's USB-C Digital AV Multiport Adapter connected to the computer, check for and apply the latest software and firmware updates.Refer to the following articles to learn more about Thunderbolt connectivity in this computer:<ul style="list-style-type: none">HT207443: Adapters for the Thunderbolt 3 (USB-C) or USB-C port on your Mac or iPad ProHT202488: Apple Thunderbolt cables and adapters

Deep Dive

	Check	Result	Action	Code	Commodity
1.	Connect the known-good display, HDMI cable, and USB-C Digital AV Multiport Adapter to the user's computer.	Yes	Go to step 2.	<code>\$(nodeText.yesSymptomCode)</code>	
	In System Preferences > Sound > Output, check for an available HDMI device for sound output. Select the available device, adjust the volume level on the display, and play the audio file or source.	No	Go to step 3.	<code>\$(nodeText.noSymptomCode)</code>	
	Can the external display audio be selected and play audio on the user's computer?				

	Check	Result	Action	Code	Commodity
2.	Connect the known-good display and HDMI cable to the user's USB-C Digital AV Multiport Adapter, then to the computer.	Yes	The issue is isolated to the user's display or HDMI cable. Inform the user of findings and refer to HT204388: Connect to HDMI from your Mac for more information.	\$(nodeText.yesSymptomCode)	
	In System Preferences > Sound > Output, check for an available HDMI device for sound output. Select the available device, adjust the volume level on the display, and play the audio file or source. Can the external display audio be selected and play audio on the user's computer?	No	The issue is isolated to the user's adapter. Replace the user's USB-C Digital AV Multiport Adapter or USB-C Digital AV VGA Adapter. If user has third-party adapter, refer to manufacturer for support.	X03	EXTERNAL CABLE
3.	Follow steps in HT208198: About Startup Security Utility to enable starting up from an external storage device on the user's computer. Start up the computer to a known-good external macOS startup volume. Connect the known-good display, HDMI cable, and USB-C Digital AV Multiport Adapter to the user's computer.	Yes	Reinstall macOS on the user's computer. Check for and apply the latest software and firmware updates. Verify that the issue is resolved.	\$(nodeText.yesSymptomCode)	
	In System Preferences > Sound > Output, check for an available HDMI device for sound output. Select the available device, adjust the volume level on the display, and play the audio file or source. Can the external display audio be selected and play audio from a known-good OS?	No	Go to step 4.	\$(nodeText.noSymptomCode)	
4.	Inspect all USB-C ports and top case openings on the user's computer for any signs of deformation, damage, or debris that may be blocking the connection. Use compressed air to clear any obstructions or debris.	Yes	Go to step 5.	\$(nodeText.yesSymptomCode)	
	Important: Do not use any metal objects to clear debris or obstructions as this can short the connector and cause damage. Is any USB-C port damaged?	No	Go to step 6.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
5.	Inspect the opening on the top case for the damaged USB-C port. Determine whether the opening is misshapen or deformed, preventing proper insertion of the USB plug.	Yes	<p>Replace the top case assembly with keyboard and trackpad.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K16	KEYBOARD
	Is the opening for the USB-C port damaged or deformed?	No	<p>Replace the damaged left or right I/O board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M24	OTHER BOARD

	Check	Result	Action	Code	Commodity
6.	<p>Troubleshooting this issue completely requires known-good left and right I/O boards.</p> <p>Do you have immediate access to known-good left and right I/O boards?</p>	Yes	Go to step 7.	\${nodeText.yesSymptomCode}	
		No	<p>Replace the affected left or right I/O board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M09	OTHER BOARD

	Check	Result	Action	Code	Commodity
7.	<p>Substitute known-good left and right I/O boards and reassemble the computer.</p> <p>Connect the known-good display, HDMI cable, and USB-C Digital AV Multiport Adapter to the user's computer. In System Preferences > Sound > Output, check for an available HDMI device for sound output. Select the available device, adjust the output volume level, and play the audio file or source.</p> <p>Can the external display audio be selected and play audio on the user's computer?</p>	Yes	<p>Replace the affected left or right I/O board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M09	OTHER BOARD
		No	<p>Reinstall the user's left and right I/O boards.</p> <p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M09	MLB
8.	<p>Play a known-good audio file or source and verify that the sound output to display speakers is functional.</p> <p>Run AST 2 Full System diagnostic suites (EFI & OS), if available, to ensure no other issues remain.</p> <p>Is the issue resolved?</p>	Yes	The issue is resolved. Verify resolution.	\${nodeText.yesSymptomCode}	
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	M99	

No Video to External Display

Unlikely causes:

Bottom case, display assembly, duckhead, eDP flex cable, fans, audio board, power adapter, top case assembly, USB-C charging cable, vent/antenna module.

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">External display not detected by computerExternal display does not show any video, but internal display doesOne external display shows video, but a second external display does not <p>Note: Inform the user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw.</p> <p>Note: If the user's issue is that the first connected external display functions, but a second connected external display does not function, try steps A through C before continuing with further troubleshooting:</p> <ol style="list-style-type: none">Ask the user if the issue only appears when multiple external displays are connected, or if the issue appears as soon as a single external display is connected.If the issue occurs only when multiple external displays are connected, then determine which external display should be connected first, to reproduce the issue during troubleshooting. The issue may only appear when multiple external displays are connected in a specific order.Repeat the troubleshooting procedure steps that follow in this flow with a second known-good USB-C Digital AV Multiport Adapter and two known-good external HDMI displays connected to the user's computer, connected in the order that causes the user's issue to appear. <ol style="list-style-type: none">Gather display type and model information from the user.Always use a known-good USB-C Digital AV Multiport Adapter and known-good HDMI display equipped with internal speakers to verify the issue.Refer to HT201177: Get help with video issues on external displays connected to your Mac for common causes of video issues.On the HDMI display, verify that the correct input has been selected.Connect the video adapter to each USB-C connector on the computer and retest each time to isolate a possible faulty USB-C port on the user's computer.Reset the NVRAM using the procedure for this computer in HT204063: Reset NVRAM or PRAM on your Mac.Reset the SMC using the procedure for this computer in HT201295: How to reset the System Management Controller (SMC) on your Mac. Retest for external video issues.Refer to HT201260: Find out which macOS your Mac is using to check that the system build is correct for this computer model.With the user's USB-C Digital AV Multiport Adapter or USB-C Digital AV VGA Adapter connected to the computer, check for and apply the latest software and firmware updates.Refer to the following articles to learn more about Thunderbolt connectivity in this computer:<ul style="list-style-type: none">HT207443: Adapters for the Thunderbolt 3 (USB-C) or USB-C port on your Mac or iPad ProHT202488: Apple Thunderbolt cables and adapters

Deep Dive

	Check	Result	Action	Code	Commodity
1.	Connect the known-good display, HDMI cable, and USB-C Digital AV Multiport Adapter to the user's computer.	Yes	Go to step 2.	\$(nodeText.yesSymptomCode)	
	Verify that a good image appears on the external display.	No	Go to step 3.	\$(nodeText.noSymptomCode)	
	Does a good image appear on the external display?				
2.	Connect the known-good display and HDMI cable to the user's USB-C Digital AV Multiport Adapter, then to the computer.	Yes	The issue is isolated to the user's display or HDMI cable. Inform the user of findings and refer to HT204388: Connect to HDMI from your Mac for more information.	\$(nodeText.yesSymptomCode)	
	Verify that a good image appears on the external display.	No	The issue is isolated to the user's adapter. Replace the user's USB-C Digital AV Multiport Adapter or USB-C Digital AV VGA Adapter. If user has third-party adapter, refer to manufacturer for support.	X03	EXTERNAL CABLE
3.	Follow steps in HT208198: About Startup Security Utility to enable starting up from an external storage device on the user's computer.	Yes	Reinstall macOS on the user's computer.	\$(nodeText.yesSymptomCode)	
	Start up the computer to a known-good external macOS startup volume.		Check for and apply the latest software and firmware updates.		
	Connect the known-good display, HDMI cable, and USB-C Digital AV Multiport Adapter to the user's computer.	No	Go to step 4.	\$(nodeText.noSymptomCode)	
	Verify that a good image appears on the external display.				
	Does a good image appear on the external display?				

	Check	Result	Action	Code	Commodity
4.	<p>Inspect all USB-C ports on the user's computer for any signs of deformation, damage, or debris that may be blocking the connection. Use compressed air to clear any obstructions or debris.</p> <p>Important: Do not use any metal objects to clear debris or obstructions as this can short the connector and cause damage.</p> <p>Is any USB-C port damaged?</p>	Yes	Go to step 5.	\$(nodeText.yesSymptomCode)	
		No	Go to step 6.	\$(nodeText.noSymptomCode)	
5.	<p>Inspect the opening on the top case for the damaged USB-C port. Determine whether the opening is misshapen or deformed, preventing proper insertion of the USB plug.</p> <p>Is the opening for the USB-C port damaged or deformed?</p>	Yes	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K16	KEYBOARD
		No	<p>Replace the damaged left or right I/O board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M24	OTHER BOARD

	Check	Result	Action	Code	Commodity
6.	<p>Troubleshooting this issue completely requires known-good left and right I/O boards.</p> <p>Do you have immediate access to known-good left and right I/O boards?</p>	Yes	Go to step 7.	\${nodeText.yesSymptomCode}	
		No	<p>Replace the affected left or right I/O board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M26	OTHER BOARD

	Check	Result	Action	Code	Commodity
7.	<p>Substitute known-good left and right I/O boards and reassemble the computer.</p> <p>Connect the known-good display, HDMI cable, and USB-C Digital AV Multiport Adapter to the user's computer.</p> <p>Verify that a good image appears on the external display.</p> <p>Does a good image appear on the external display?</p>	Yes	<p>Replace the affected left or right I/O board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M26	OTHER BOARD
		No	<p>Reinstall the user's left and right I/O boards.</p> <p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M26	MLB
8.	<p>Restart the computer and verify that a known-good external display works using both VGA and digital AV adapters.</p> <p>Run AST 2 Full System diagnostic suites (EFI & OS), if available, to ensure no other issues remain.</p> <p>Is the issue resolved?</p>	Yes	The issue is resolved. Verify resolution.	\${nodeText.yesSymptomCode}	
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	M99	

Power Button or Touch ID Issues

Unlikely causes:

Bottom case, Display assembly, AC Wall adapter (duckhead), eDP flex cable, Fan, Keyboard flex cable, I/O board, Audio board, Logic board, Power adapter, Power cord, Speaker set (L&R) (some models), Trackpad (some models), USB-C charging cable, Vent/antenna module

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">• Power button does not click properly or at all.• Power button has stiff or spongy feel when pressed.• Touch ID is unable to read user's fingerprint.• Unable to enroll a user's finger in Touch ID.• Unable to unlock computer using Touch ID.• Unable to make purchase using Apple Pay and Touch ID. <p>Note: Inform user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover and disconnected the battery.</p> <ol style="list-style-type: none">1. Restart the user's computer. After starting up, the user's computer will first prompt for a passcode, not a fingerprint, even if Touch ID is enabled. This is normal behavior. The only time the computer will authenticate using Touch ID is when waking from sleep, not when starting up.2. On the computer, have the user go to System Preferences > Touch ID to verify that user has enrolled at least one fingerprint. If no fingerprint is enrolled, Touch ID will be unable to function as expected.3. Also in System Preferences > Touch ID, verify that the box next to Unlocking your Mac is checked. If it is not, then Touch ID will not unlock the computer. Verify that the box next to iTunes & App Store is checked. If it is not, then Touch ID cannot be used to make purchases in the iTunes Store, App Store, and iBooks Store. Refer to HT207054: Use Touch ID on your Mac for more information about these settings.4. Refer to HT207037: If the Touch Bar or Touch ID doesn't work on MacBook Pro (15-inch, 2016) or MacBook Pro (13-inch, 2016, Four Thunderbolt 3 Ports).5. Refer to HT207348: If a customer's MacBook or MacBook Pro shows a critical software update error.6. Refer to HT201260: Find out which macOS your Mac is using to check that the system build is correct for this computer model. Apply the latest software and firmware updates.7. Ensure that the customer's finger and the Touch ID sensor are clean. Check for dirt, debris, oils, lotions, or signs of damage. If necessary, clean the Touch ID sensor and the area surrounding it on the user's computer using a clean microfiber cloth.8. Check for cases or protective films. Remove them if they are obstructing the Touch ID sensor or the area surrounding it and then retest for Touch ID functionality.9. Have the user try to enroll another fingerprint on the same computer.10. Remember that the user's finger needs to move slightly during enrollment. Also, ensure that the user waits for the computer's prompt before lifting a finger.11. If user's finger does not reliably work on their computer, try enrolling the user's fingerprint on another known-good computer.12. Enroll your own finger with the user's computer and retest for Touch ID functionality. Be sure to remove any non-user fingerprints from the computer when testing is complete so that you do not inadvertently leave your biometric information on a user's computer.13. Reset the NVRAM using the procedure for this computer in HT204063: Reset NVRAM or PRAM on your Mac.14. Reset the SMC using the procedure listed for this computer in HT201295: How to reset the System Management Controller (SMC) on your Mac. Do not hold in the power button when turning on the computer. You could inadvertently put the computer into DFU mode if

	<p>you do.</p> <p>15. Do not service or replace the computer for issues with a specific finger or fingers. If the user has an issue with certain fingers, explain that in some cases Touch ID may be unable to match those fingers consistently. This is usually caused by the readability of that fingerprint, and the user can either try enrolling the fingerprint at a later time, or use a different finger for Touch ID.</p> <p>If you and the user are unable to enroll any fingerprints on the computer, there is an issue with the Touch ID sensor and the computer should be serviced.</p>
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Deep Dive

	Check	Result	Action	Code	Commodity
1.	Identify the type of issue:	A	Go to step 2.	<code>\${nodeText.yesSymptomCode}</code>	
	<p>A. Touch ID issues such as:</p> <ul style="list-style-type: none"> Unable to read user's fingerprint Unable to enroll a user's fingerprint in Touch ID Unable to unlock computer using Touch ID Unable to make a purchase using Apple Pay and Touch ID <p>B. Power button issues such as:</p> <ul style="list-style-type: none"> Power button does not click properly or at all Power button has a stiff or spongy feel when pressed <p>Which issue is identified?</p>	B	Go to step 11.	<code>\${nodeText.noSymptomCode}</code>	
2.	Follow steps in Apple Configurator 2 User Guide to restore the T2 firmware on the user's computer.	Yes	Go to step 3.	<code>\${nodeText.yesSymptomCode}</code>	
	<p>Restart the computer and verify that it completely starts up to macOS.</p> <p>Retest Touch ID.</p> <p>Does the issue persist after restoring T2 firmware?</p>	No	The issue was resolved by restoring T2 firmware.	<code>\${nodeText.noSymptomCode}</code>	
3.	Run AST 2 Touch ID diagnostic suite on user's computer.	Yes	Go to step 4.	<code>\${nodeText.yesSymptomCode}</code>	
	<p>Check diagnostic results to verify the functionality of Touch ID hardware.</p> <p>If AST 2 is not available, repeat Quick Check steps to verify Touch ID functionality.</p> <p>Does the computer pass all tests?</p>	No	Go to step 5.	<code>\${nodeText.noSymptomCode}</code>	

	Check	Result	Action	Code	Commodity
4.	Repeat Quick Check steps to verify Touch ID functionality.	Yes	Issue cannot be duplicated.	\$(nodeText.yesSymptomCode)	
	Touch ID is not responding as expected if: <ul style="list-style-type: none"> There are authentication errors or failures on the user's computer when attempting to use any finger. Multiple people are having problems enrolling any fingerprint. Registration process cannot begin because the computer cannot detect any finger. 	No	Go to step 5.	\$(nodeText.noSymptomCode)	
	Is Touch ID responding as expected?				
5.	Isolate the Touch ID issue to one of the following symptoms:	Intermittent Response	Go to step 6.	\$(nodeText.yesSymptomCode)	
	<ul style="list-style-type: none"> Intermittent response to finger No response to finger 	No Response	Go to step 7.	\$(nodeText.noSymptomCode)	
	Which issue affects Touch ID?				
6.	Check for and apply the latest software and firmware updates to the user's computer.	Yes	Issue resolved by updating macOS.	\$(nodeText.yesSymptomCode)	
	Run AST 2 Touch ID & Touch Bar diagnostic suite on user's computer to retest Touch ID after software update.	No	Go to step 7.	\$(nodeText.noSymptomCode)	
	Is the issue resolved after software update?				
7.	For MacBook Pro (15-inch), reply "Yes" to continue troubleshooting.	Yes	Go to step 10.	\$(nodeText.yesSymptomCode)	
	Follow Service Guide procedures to gain access to the Touch ID board in the top case.				
	Visually inspect that the PSA is properly aligned to the Touch ID board flex cable.				
7.	Verify that the PSA is holding this flex cable against its grounding point on the logic board.	No	Go to step 8.	\$(nodeText.noSymptomCode)	
	If the flex cable is not grounded, this may prevent Touch ID from functioning properly or at all.				
	Is this cable and PSA seated properly?				

	Check	Result	Action	Code	Commodity
8.	Disconnect the Touch ID board flex cable and peel back the PSA strip holding it to the logic board grounding point.	Yes	Go to step 9.	`\${nodeText.yesSymptomCode}`	
	Clean off the existing PSA from the logic board and replace the existing PSA strip with a new PSA strip.				
	Reseat the Touch ID board flex cable, ensuring that the PSA is holding this flex cable against its grounding point on the logic board to provide a good ground.	No	Go to step 10.	`\${nodeText.noSymptomCode}`	
	Are you able to reseat this cable?				
9.	Reassemble the computer.				
	Run AST 2 Touch ID & Touch Bar diagnostic suite on user's computer to retest Touch ID after reseating the Touch ID board flex cable.	Yes	Issue resolved by reseating Touch ID board flex cable and PSA.	`\${nodeText.yesSymptomCode}`	
	Is the issue resolved after reseating cable?	No	Go to step 10.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
10.	Isolate the Touch ID issue to one of the following symptoms: <ul style="list-style-type: none"> • Touch ID functionality • Apple Pay Which issue affects Touch ID?	Touch ID	Replace the Touch ID board. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair. Verify that the issue is resolved.	M46	MPU
		Apple Pay	Replace the Touch ID board. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair. Verify that the issue is resolved.	M47	MPU

	Check	Result	Action	Code	Commodity
11.	<p>Inspect the opening on the top case for the power button.</p> <p>Determine whether the opening is misshapen or deformed, preventing proper button operation.</p> <p>Is the opening for the power button damaged or deformed?</p>	Yes	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K16	KEYBOARD
		No	Go to step 12.	\$(nodeText.noSymptomCode)	
12.	<p>Follow Service Guide procedures to remove the bottom case and the logic board to gain access to the Touch ID board in the top case.</p> <p>Follow Service Guide procedures to remove the Touch ID board. Inspect the gap between the top case and the Touch ID board for debris.</p> <p>If any debris is found that may interfere with power button operation, use compressed air to clean out the debris.</p> <p>Follow Service Guide procedures to reassemble the computer and retest for both power button and Touch ID functionality.</p> <p>Is the issue resolved?</p>	Yes	Issue resolved by cleaning Touch ID board area in top case.	\$(nodeText.yesSymptomCode)	
		No	Go to step 13.	\$(nodeText.noSymptomCode)	
13.	<p>Troubleshooting this issue completely requires a known-good Touch ID shim kit.</p> <p>Do you have immediate access to a Touch ID shim kit?</p>	Yes	Go to step 14.	\$(nodeText.yesSymptomCode)	
		No	<p>Order a Touch ID shim kit.</p> <p>Return to this procedure when the kit is available.</p>	X03	PIECE PART

	Check	Result	Action	Code	Commodity
14.	<p>A button that feels too loose or too stiff can be caused by installing an incorrect shim that is too large or small.</p> <p>If the button is not aligned, then follow Service Guide procedures to realign the Touch ID board in the top case.</p> <p>If the button feels too loose or has a spongy feel, then try a larger shim.</p> <p>If the button feels too stiff or does not move, then try a smaller shim.</p> <p>Reinstall the same Touch ID board using the new shim.</p> <p>Reassemble the computer and retest for both power button and Touch ID functionality.</p> <p>Is the issue resolved?</p>	Yes	Issue resolved by adjusting Touch ID board shim size.	\$(nodeText.yesSymptomCode)	
		No	<p>Replace the Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M48	MPU
15.	<p>Verify that the Touch ID or power button issue or anomaly is no longer present.</p> <p>Run AST 2 Full System diagnostic suites (EFI & OS), if available, to ensure no other issues remain.</p> <p>Is the issue resolved?</p>	Yes	The issue is resolved.	\$(nodeText.yesSymptomCode)	
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	K99	

Touch Bar Issues

Unlikely causes:

Bottom case, Display assembly, AC Wall adapter (duckhead), eDP flex cable, Fan, Keyboard flex cable, I/O board, Audio board, Power adapter, Power cord, USB-C charging cable, Vent/antenna module

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">• Touch Bar image quality issues• Touch Bar touch response issues• Touch Bar functionality issues <p>Note: Inform user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover and disconnected the battery.</p> <p>Note: This procedure is intended for display and touch response issues with the Touch Bar display only. If the user has display issues with the main display, return to the list of symptoms and choose “Display Anomalies” or “Cracked Glass” from the troubleshooting menu.</p> <ol style="list-style-type: none">1. Refer to HT207055: How to use the Touch Bar on your MacBook Pro and HT207240: How to use function keys on MacBook Pro with Touch Bar for information about the Touch Bar.2. Refer to HT207037: If the Touch Bar or Touch ID doesn't work on MacBook Pro (15-inch, 2016) or MacBook Pro (13-inch, 2016, Four Thunderbolt 3 Ports).3. Refer to HT207348: If a customer's MacBook or MacBook Pro shows a critical software update error message.4. Refer to HT201260: Find out which macOS your Mac is using to check that the system build is correct for this computer model.5. The Touch Bar backlight should change brightness when the ambient light sensor (ALS) detects low light conditions. Check System Preferences > Displays to see whether the “Automatically adjust brightness” option is selected.6. Check ALS functionality by covering the sensor (located on the display assembly near the camera) with your hand to simulate a dark room. Check whether the Touch Bar backlight brightness increases.7. Check for and apply the latest software and firmware updates.8. Reset the NVRAM using the procedure for this computer in HT204063: Reset NVRAM or PRAM on your Mac.9. Reset the SMC using the procedure listed for this computer in HT201295: How to reset the System Management Controller (SMC) on your Mac. Do not hold in the power button when turning on the computer. You could inadvertently put the computer into DFU mode if you do.

Deep Dive

	Check	Result	Action	Code	Commodity
1.	<p>Follow steps in Apple Configurator 2 User Guide to restore the T2 firmware on the user's computer.</p> <p>Restart the computer and verify that it completely starts up to macOS.</p> <p>Retest the Touch Bar.</p> <p>Does the issue persist after restoring T2 firmware?</p>	Yes	Go to step 2.	`\${nodeText.yesSymptomCode}`	
		No	The issue was resolved by restoring T2 firmware.	`\${nodeText.noSymptomCode}`	
2.	<p>Thoroughly clean the Touch Bar surface to remove any dust or debris.</p> <p>Examine the cleaned Touch Bar and try to reproduce the issue.</p> <p>Is the issue resolved by cleaning the Touch Bar?</p>	Yes	The issue has been resolved by cleaning the Touch Bar. Verify resolution.	`\${nodeText.yesSymptomCode}`	
		No	Go to step 3.	`\${nodeText.noSymptomCode}`	
3.	<p>Shut down the unit and examine the area of the Touch Bar that is affected by the symptom under a bright light source.</p> <p>Check that the affected area is not damaged by scratches, pits, or damage to the display coating.</p> <p>Refer to TP1138: Visual/Mechanical Inspection (VMI) Guide for Mac Displays for more information.</p> <p>Does the Touch Bar surface appear damaged?</p>	Yes	Go to step 4.	`\${nodeText.yesSymptomCode}`	
		No	Go to step 8.	`\${nodeText.noSymptomCode}`	
4.	<p>Closely examine the Touch Bar for signs of damage, such as the following:</p> <ul style="list-style-type: none"> Glass or polarizer scratch, dent. <p>Does the computer exhibit this type of damage?</p>	Yes	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K55	KEYBOARD
		No	Go to step 5.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
5.	<p>Closely examine the Touch Bar for signs of damage, such as the following:</p> <ul style="list-style-type: none"> Glass or polarizer antireflective coating damaged. <p>Does the computer exhibit this type of damage?</p>	Yes	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K56	KEYBOARD
		No	Go to step 6.	\${nodeText.noSymptomCode}	
6.	<p>Closely examine the Touch Bar for signs of damage, such as the following:</p> <ul style="list-style-type: none"> Touch Bar display has a single crack. <p>Does the computer exhibit this type of damage?</p>	Yes	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K57	KEYBOARD
		No	Go to step 7.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
7.	<p>Closely examine the Touch Bar for signs of damage, such as the following:</p> <ul style="list-style-type: none"> • Touch Bar display has multiple cracks. <p>Does the computer exhibit this type of damage?</p>	Yes	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K58	KEYBOARD
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	K99	KEYBOARD
8.	<p>Run AST 2 Touch ID & Touch Bar, Touch Bar Pixel Anomalies, and Touch Bar Response tests to verify the presence of the Touch Bar, Touch Bar display, and touch functionality. Examine diagnostic results.</p> <p>Does the computer pass all tests?</p>	Yes	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	K99	
		No	Go to step 9.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
9.	<p>Follow Service Guide procedures to remove the bottom case and disconnect the battery from the logic board.</p> <p>Disconnect the Touch Bar touch and display flex cables from the logic board and inspect them for damage.</p> <p>Both of these cables run under the logic board.</p> <p>Pay attention to the body of the cables, looking for tearing, pinching, or crimping. Also examine the connectors for damage.</p> <p>Does either of these cables show signs of damage?</p>	Yes	Go to step 10.	\${nodeText.yesSymptomCode}	
		No	Go to step 11.	\${nodeText.noSymptomCode}	
10.	<p>Inspect the logic board Touch Bar touch and display flex connectors for damage.</p> <p>Are the Touch Bar touch or display flex connectors on the logic board also damaged?</p>	Yes	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	K99	
		No	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K16	KEYBOARD
11.	<p>Inspect the logic board Touch Bar touch and display flex connectors for damage.</p> <p>Are the Touch Bar touch or display flex connectors on the logic board damaged?</p>	Yes	Go to step 12.	\${nodeText.yesSymptomCode}	
		No	Go to step 13.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
12.	<p>Inspect the top case Touch Bar touch and display flex cables for damage.</p> <p>Pay attention to the body of the cables, looking for tearing, pinching, or crimping.</p> <p>Also examine the connectors for damage.</p> <p>Does either of these cables also show signs of damage?</p>	Yes	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	K99	
		No	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M24	MLB
13.	<p>Reconnect the Touch Bar touch and display flex cables to the logic board, verifying that the connections are all seated properly.</p> <p>Reassemble the computer, then run AST 2 Touch ID & Touch Bar, Touch Bar Pixel Anomalies, and Touch Bar Response tests to verify Touch Bar display and touch functionality. Examine diagnostic results.</p> <p>Does the computer pass all tests?</p>	Yes	The issue was resolved by reseating the Touch Bar flex cables. Verify resolution.	\${nodeText.yesSymptomCode}	
		No	Go to step 14.	\${nodeText.noSymptomCode}	
14.	<p>To troubleshoot this issue completely, a known-good top case assembly is required.</p> <p>Do you have immediate access to a known-good top case assembly?</p>	Yes	Go to step 15.	\${nodeText.yesSymptomCode}	
		No	Go to step 16.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
15.	Substitute a known-good top case assembly.	Yes	Go to step 16.	#{nodeText.yesSymptomCode}	
	Reassemble the computer, then run AST 2 Touch ID & Touch Bar, Touch Bar Pixel Anomalies, and Touch Bar Response tests to verify Touch Bar display and touch functionality. Examine diagnostic results.	No	Go to step 29.	#{nodeText.noSymptomCode}	
	Does the computer pass all tests?				
16.	Isolate the original symptom for this issue as:		Replace the top case assembly.		
	<ul style="list-style-type: none"> Incorrect colors or tinting. 	Yes	Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.	K44	KEYBOARD
	Does this symptom best describe the original issue?	No	Go to step 17.	#{nodeText.noSymptomCode}	
17.	Isolate the original symptom for this issue as:		Replace the top case assembly.		
	<ul style="list-style-type: none"> Image is blank or no image on Touch Bar. 	Yes	Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.	K45	KEYBOARD
	Does this symptom best describe the original issue?	No	Go to step 18.	#{nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
18.	<p>Isolate the original symptom for this issue as:</p> <ul style="list-style-type: none"> Image is distorted, blurred, or out of focus. <p>Does this symptom best describe the original issue?</p>	Yes	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K46	KEYBOARD
		No	Go to step 19.	\${nodeText.noSymptomCode}	
19.	<p>Isolate the original symptom for this issue as:</p> <ul style="list-style-type: none"> Image flickers or flashes. <p>Does this symptom best describe the original issue?</p>	Yes	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K47	KEYBOARD
		No	Go to step 20.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
20.	<p>Isolate the original symptom for this issue as:</p> <ul style="list-style-type: none"> Cannot control image brightness. <p>Does this symptom best describe the original issue?</p>	Yes	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K48	KEYBOARD
		No	Go to step 21.	\${nodeText.noSymptomCode}	
21.	<p>Isolate the original symptom for this issue as:</p> <ul style="list-style-type: none"> Dead pixels or foreign material. <p>Does this symptom best describe the original issue?</p>	Yes	Go to step 22.	\${nodeText.yesSymptomCode}	
		No	Go to step 23.	\${nodeText.noSymptomCode}	
22.	<p>Use the Touch Bar Pixel Anomalies test in AST 2 to verify Touch Bar display for pixel anomalies. Examine diagnostic results.</p> <p>Refer to HT202025: About LCD display pixel anomalies for Apple products released in 2010 and later to determine whether the number of defects in the display exceeds specification.</p> <p>Does the number of pixel anomalies exceed the specified limit?</p>	Yes	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K49	KEYBOARD
		No	The Touch Bar display is within specification.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
23.	<p>Isolate the original symptom for this issue as:</p> <ul style="list-style-type: none"> • Bad spots. <p>Does this symptom best describe the original issue?</p>	Yes	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K50	KEYBOARD
		No	Go to step 24.	\$_{nodeText.noSymptomCode}	
24.	<p>Isolate the original symptom for this issue as:</p> <ul style="list-style-type: none"> • Image sticking or ghosting. <p>Does this symptom best describe the original issue?</p>	Yes	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K51	KEYBOARD
		No	Go to step 25.	\$_{nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
25.	<p>Isolate the original symptom for this issue as:</p> <ul style="list-style-type: none"> Image has horizontal lines or bands. <p>Does this symptom best describe the original issue?</p>	Yes	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K52	KEYBOARD
		No	Go to step 26.	\${nodeText.noSymptomCode}	
26.	<p>Isolate the original symptom for this issue as:</p> <ul style="list-style-type: none"> Image has vertical lines or bands. <p>Does this symptom best describe the original issue?</p>	Yes	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K53	KEYBOARD
		No	Go to step 27.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
27.	<p>Isolate the original symptom for this issue as:</p> <ul style="list-style-type: none"> Light leakage around the Touch Bar display. <p>Does this symptom best describe the original issue?</p>	Yes	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K54	KEYBOARD
		No	Go to step 28.	\${nodeText.noSymptomCode}	
28.	<p>Isolate the original symptom for this issue as:</p> <ul style="list-style-type: none"> Touch Bar not responding to touch gestures. <p>Does this symptom best describe the original issue?</p>	Yes	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K59	KEYBOARD
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	K99	

	Check	Result	Action	Code	Commodity
29.	<p>Isolate the original symptom for this issue as:</p> <ul style="list-style-type: none"> Image is blank or no image on Touch Bar. <p>Does this symptom best describe the original issue?</p>	Yes	<p>Reinstall the user's top case assembly.</p> <p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M03	MLB
		No	Go to step 30.	\${nodeText.noSymptomCode}	
30.	<p>Isolate the original symptom for this issue as:</p> <ul style="list-style-type: none"> Image is distorted, blurred, or out of focus. <p>Does this symptom best describe the original issue?</p>	Yes	<p>Reinstall the user's top case assembly.</p> <p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M04	MLB
		No	Go to step 31.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
31.	<p>Isolate the original symptom for this issue as:</p> <ul style="list-style-type: none"> • Touch Bar display has no or dim backlight. <p>Does this symptom best describe the original issue?</p>	Yes	<p>Reinstall the user's top case assembly.</p> <p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M25	MLB
		No	Go to step 32.	\${nodeText.noSymptomCode}	
32.	<p>Isolate the original symptom for this issue as:</p> <ul style="list-style-type: none"> • Image flickers or flashes. <p>Does this symptom best describe the original issue?</p>	Yes	<p>Reinstall the user's top case assembly.</p> <p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M29	MLB
		No	Go to step 33.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
33.	<p>Isolate the original symptom for this issue as:</p> <ul style="list-style-type: none"> • Touch Bar not responding to touch gestures. <p>Does this symptom best describe the original issue?</p>	Yes	<p>Reinstall the user's top case assembly.</p> <p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M99	MLB
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	K99	
34.	<p>Verify that the Touch Bar issue or anomaly is no longer present.</p> <p>Run AST 2 Full System diagnostic suites (EFI & OS), if available, to ensure no other issues remain.</p> <p>Is the issue resolved?</p>	Yes	The issue is resolved.	\${nodeText.yesSymptomCode}	
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	K99	

USB-C and Thunderbolt Connectivity Issues

Unlikely causes:

Bottom case, display assembly, duckhead, eDP flex cable, fans, keyboard flex cable, audio board, power adapter, USB-C charging cable, vent/antenna module

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">Standard USB-C devices not recognized or not powered when connected to computer's USB-C port(s).USB 2 or USB 3 devices not recognized or not powered when connected to computer's USB-C port(s).External DisplayPort or Thunderbolt devices or displays not recognized when connected to computer's USB-C port(s). <p>Note: Inform the user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw.</p> <p>Note: If the user's issue is that the first connected external display functions, but a second connected external display does not function, try steps A through C before continuing with further troubleshooting:</p> <ol style="list-style-type: none">Ask the user if the issue occurs only when multiple external displays are connected, or if the issue occurs as soon as a single external display is connected.If the issue only appears when multiple external displays are connected, then determine which external display should be connected first, to reproduce the issue during troubleshooting. The issue may only appear when multiple external displays are connected in a specific order.Repeat the troubleshooting procedure steps that follow in this flow with a second known-good USB-C Digital AV Multiport Adapter and two known-good external HDMI displays connected to the user's computer, connected in the order that causes the user's issue to appear. <ol style="list-style-type: none">Verify that any USB hubs connected to the computer have sufficient power for a connected USB device.Check whether the user's USB device requires a specific driver to function properly.If the user is using a USB 3 device, review HT201163: Using USB devices with your Mac.Reset the NVRAM using the procedure for this computer in HT204063: Reset NVRAM or PRAM on your Mac.Reset the SMC using the procedure for this computer in HT201295: How to reset the System Management Controller (SMC) on your Mac. Retest for USB-C connectivity issues.Refer to HT201260: Find out which macOS your Mac is using to check that the system build is correct for this computer model.Using a Wi-Fi network, check for and apply the latest software and firmware updates. Also check for adapter firmware updates by leaving the user's adapter connected to the computer while running software update. If an update is available, update the adapter's firmware before proceeding further, and retest for USB-C connectivity issues.Refer to HT207443: Adapters for the Thunderbolt 3 (USB-C) or USB-C port on your Mac or iPad Pro to learn more about Thunderbolt connectivity in this computer.

Deep Dive

	Check	Result	Action	Code	Commodity
1.	<p>Inspect all USB-C ports and top case openings on the user's computer for any signs of deformation, damage, or debris that may be blocking the connection. Use compressed air to clear any obstructions or debris.</p> <p>If possible, also inspect the electromagnetic interference (EMI) springs on each USB-C connector to ensure they are not bent or otherwise damaged.</p> <p>Important: Do not use any metal objects to clear debris or obstructions as this can short the connector and cause damage.</p> <p>Is any USB-C port damaged?</p>	Yes	Go to step 2.	`\${nodeText.yesSymptomCode}`	
		No	Go to step 3.	`\${nodeText.noSymptomCode}`	
2.	<p>Inspect the opening on the top case for the USB-C port. Determine whether the opening is misshapen or deformed, preventing proper insertion of the USB plugs.</p> <p>Is the opening for the USB-C port damaged or deformed?</p>	Yes	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K16	KEYBOARD
		No	Go to step 13.	`\${nodeText.noSymptomCode}`	
3.	<p>Connect the user's computer to a known-good Apple USB-C power adapter with a known-good Apple USB-C charging cable that is the correct type for the user's computer.</p> <p>Connect the power adapter to a known-good electrical outlet.</p> <p>Check that the computer recognizes the power adapter.</p> <p>The computer should turn on automatically if it is off when the power adapter is connected.</p> <p>Does the computer recognize the power adapter and turn on?</p>	Yes	Go to step 4.	`\${nodeText.yesSymptomCode}`	
		No	Go to "Does Not Run on Power Adapter" troubleshooting flow.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
4.	Shut down the computer.	Yes	Go to step 5.	`\${nodeText.yesSymptomCode}`	
	<p>Disconnect and flip the orientation of the USB-C charging cable plug, then reconnect it to the same USB-C port on the computer and retest to test both orientations.</p> <p>The computer should turn on automatically.</p> <p>Does the computer recognize the power adapter and turn on?</p>	No	Go to “Does Not Run on Power Adapter” troubleshooting flow.	`\${nodeText.noSymptomCode}`	
5.	Using an Apple USB-C to USB Adapter, connect a known-good high-speed USB (1.1/2.0) device, such as a mouse, keyboard, or USB 2 flash drive to the same USB-C port on the computer.	Yes	Go to step 6.	`\${nodeText.yesSymptomCode}`	
	<p>Verify in System Information > USB that the device is detected.</p> <p>Is the USB 1.1/2.0 device detected?</p>	No	Go to step 13.	`\${nodeText.noSymptomCode}`	
6.	Disconnect and flip the orientation of the USB-C Apple adapter cable plug, then reconnect it to the same USB-C port on the computer and retest, to test both orientations.	Yes	Go to step 7.	`\${nodeText.yesSymptomCode}`	
	<p>Refresh the USB Device Tree in System Information by pressing Command-R, or by choosing File > Refresh Information from the menu bar.</p> <p>Verify in System Information > USB that the device is detected.</p> <p>Is the USB 1.1/2.0 device detected?</p>	No	Go to step 13.	`\${nodeText.noSymptomCode}`	
7.	Using a known-good Apple USB-C to USB Adapter, connect a known-good USB 3 device, such as a USB 3 hard drive or flash drive, to the same USB-C port on the computer.	Yes	Go to step 8.	`\${nodeText.yesSymptomCode}`	
	<p>Verify in System Information > USB that the device is detected.</p> <p>Is the USB 3 device detected?</p>	No	Go to step 13.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
8.	<p>Disconnect and flip the orientation of the USB-C Apple adapter cable plug, then reconnect it to the same USB-C port on the computer and retest, to test both orientations.</p> <p>Refresh the USB Device Tree in System Information by pressing Command-R, or by choosing File > Refresh Information from the menu bar.</p> <p>Verify in System Information > USB that the device is detected.</p> <p>Is the USB 3 device detected?</p>	Yes	Go to step 9.	`\${nodeText.yesSymptomCode}`	
		No	Go to step 13.	`\${nodeText.noSymptomCode}`	
9.	<p>Using the user's Apple USB-C to USB Adapter in place of the known-good adapter, connect a known-good USB 3 device, such as a USB 3 hard drive or flash drive to the same USB-C port on the computer.</p> <p>Refer to HT207443: Adapters for the Thunderbolt 3 (USB-C) or USB-C port on your Mac or iPad Pro for more information about Apple USB-C adapters.</p> <p>Refresh the USB Device Tree in System Information by pressing Command-R, or by choosing File > Refresh Information from the menu bar.</p> <p>Verify in System Information > USB that the device is detected.</p> <p>Be sure to test both orientations.</p> <p>Is the USB 3 device detected?</p>	Yes	Go to step 10.	`\${nodeText.yesSymptomCode}`	
		No	<p>Replace the user's Apple USB-C adapter.</p> <p>If the adapter is made by a third party, advise the user to contact the manufacturer for support.</p> <p>Verify that the issue is resolved.</p>	X03	EXTERNAL CABLE
10.	<p>Using a known-good Apple Thunderbolt 3 (USB-C) to Thunderbolt 2 Adapter, connect a known-good external Thunderbolt 2 device such as a display or external disk to the same USB-C port on the computer.</p> <p>Verify in System Information > Thunderbolt that the device is detected.</p> <p>Refer to HT207266: About the Apple Thunderbolt 3 (USB-C) to Thunderbolt 2 Adapter for more information about this adapter.</p> <p>Is the Thunderbolt 2 device detected?</p>	Yes	Go to step 11.	`\${nodeText.yesSymptomCode}`	
		No	Go to step 20.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
11.	<p>Disconnect and flip the orientation of the USB-C Apple adapter cable plug, then reconnect it to the same USB-C port on the computer and retest, to test both orientations.</p> <p>Refresh the USB Device Tree in System Information by pressing Command-R, or by choosing File > Refresh Information from the menu bar.</p> <p>Verify in System Information > Thunderbolt that the device is detected.</p> <p>Is the Thunderbolt 2 device detected?</p>	Yes	Go to step 12.	`\${nodeText.yesSymptomCode}`	
		No	Go to step 20.	`\${nodeText.noSymptomCode}`	
12.	<p>Using the user's Apple Thunderbolt 3 (USB-C) to Thunderbolt 2 Adapter in place of the known-good adapter, connect a known-good external Thunderbolt 2 device such as a display or external disk to the same USB-C port on the computer.</p> <p>Refer to HT207443: Adapters for the Thunderbolt 3 (USB-C) or USB-C port on your Mac or iPad Pro for more information about Apple USB-C adapters.</p> <p>Refresh the USB Device Tree in System Information by pressing Command-R, or by choosing File > Refresh Information from the menu bar.</p> <p>Verify in System Information > Thunderbolt that the device is detected.</p> <p>Be sure to test both orientations.</p> <p>Is the Thunderbolt 2 device detected?</p>	Yes	Go to "No Video to External Display" troubleshooting flow.	`\${nodeText.yesSymptomCode}`	
		No	<p>Replace the user's Apple USB-C adapter.</p> <p>If the adapter is made by a third party, advise the user to contact the manufacturer for support.</p> <p>Verify that the issue is resolved.</p>	X03	EXTERNAL CABLE

	Check	Result	Action	Code	Commodity
13.	<p>Inspect all USB-C ports on the computer for any visible damage or debris that may be preventing a connection.</p> <p>Also inspect the EMI springs on each USB-C connector to ensure they are not bent or otherwise damaged.</p> <p>Clear any debris as necessary.</p> <p>Important: Do not use any metal objects to clear debris or obstructions as this can short the connector and cause damage.</p> <p>Is any USB-C port damaged?</p>	Yes	<p>Replace the damaged left or right I/O board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M24	OTHER BOARD
		No	Go to step 14.	\$(nodeText.noSymptomCode)	
14.	<p>Troubleshooting this issue completely requires a known-good I/O board.</p> <p>Do you have immediate access to a known-good I/O board?</p>	Yes	Go to step 15.	\$(nodeText.yesSymptomCode)	
		No	Go to step 16.	\$(nodeText.noSymptomCode)	
15.	<p>Substitute a known-good I/O board and reassemble the computer.</p> <p>Retest for USB-C functionality.</p> <p>Is the issue resolved?</p>	Yes	Go to step 16.	\$(nodeText.yesSymptomCode)	
		No	Go to step 18.	\$(nodeText.noSymptomCode)	
16.	<p>Determine if the following symptom was observed on the user's computer:</p> <ul style="list-style-type: none"> USB device not detected. <p>Does this symptom accurately describe the user's issue?</p>	Yes	<p>Replace the affected left or right I/O board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M37	OTHER BOARD
		No	Go to step 17.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
17.	<p>Determine if the following symptom was observed on the user's computer:</p> <ul style="list-style-type: none"> • USB port has insufficient power. <p>Does this symptom accurately describe the user's issue?</p>	Yes	<p>Replace the affected left or right I/O board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M38	OTHER BOARD
		No	<p>Replace the affected left or right I/O board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M15	OTHER BOARD

	Check	Result	Action	Code	Commodity
18.	<p>Determine if the following symptom was observed on the user's computer:</p> <ul style="list-style-type: none"> • USB device not detected. <p>Does this symptom accurately describe the user's issue?</p>	Yes	<p>Reinstall the user's I/O board.</p> <p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M37	MLB
		No	Go to step 19.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
19.	<p>Determine if the following symptom was observed on the user's computer:</p> <ul style="list-style-type: none"> • USB port has insufficient power. <p>Does this symptom accurately describe the user's issue?</p>	Yes	<p>Reinstall the user's I/O board.</p> <p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M38	MLB
		No	<p>Reinstall the user's I/O board.</p> <p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M15	MLB

	Check	Result	Action	Code	Commodity
20.	<p>Inspect all USB-C ports on the computer for any visible damage or debris that may be preventing a connection.</p> <p>Also inspect the EMI springs on each USB-C connector to ensure they are not bent or otherwise damaged.</p> <p>Clear any debris as necessary.</p> <p>Important: Do not use any metal objects to clear debris or obstructions as this can short the connector and cause damage.</p> <p>Is any USB-C port damaged?</p>	Yes	<p>Replace the damaged left or right I/O board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M24	OTHER BOARD
		No	Go to step 21.	\$(nodeText.noSymptomCode)	
21.	<p>Troubleshooting this issue completely requires a known-good I/O board.</p> <p>Do you have immediate access to a known-good I/O board?</p>	Yes	Go to step 22.	\$(nodeText.yesSymptomCode)	
		No	Go to step 23.	\$(nodeText.noSymptomCode)	
22.	<p>Substitute a known-good I/O board and reassemble the computer.</p> <p>Retest for USB-C functionality.</p> <p>Is the issue resolved?</p>	Yes	Go to step 23.	\$(nodeText.yesSymptomCode)	
		No	Go to step 25.	\$(nodeText.noSymptomCode)	
23.	<p>Determine if the following symptom was observed on the user's computer:</p> <ul style="list-style-type: none"> • USB device not detected. <p>Does this symptom accurately describe the user's issue?</p>	Yes	<p>Replace the affected left or right I/O board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M37	OTHER BOARD
		No	Go to step 24.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
24.	<p>Determine if the following symptom was observed on the user's computer:</p> <ul style="list-style-type: none"> • USB port has insufficient power. <p>Does this symptom accurately describe the user's issue?</p>	Yes	<p>Replace the affected left or right I/O board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M38	OTHER BOARD
		No	<p>Replace the affected left or right I/O board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M15	OTHER BOARD

	Check	Result	Action	Code	Commodity
25.	<p>Determine if the following symptom was observed on the user's computer:</p> <ul style="list-style-type: none"> Thunderbolt display functionality issue. <p>Does this symptom accurately describe the user's issue?</p>	Yes	<p>Reinstall the user's I/O board.</p> <p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M32	MLB
		No	Go to step 26.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
26.	<p>Determine if the following symptom was observed on the user's computer:</p> <ul style="list-style-type: none"> Thunderbolt not providing enough power. <p>Does this symptom accurately describe the user's issue?</p>	Yes	<p>Reinstall the user's I/O board.</p> <p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M34	MLB
		No	<p>Reinstall the user's I/O board.</p> <p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M33	MLB

	Check	Result	Action	Code	Commodity
27.	<p>Confirm that known-good USB high-speed and SuperSpeed devices and Thunderbolt 2 devices are functional and recognized when connected to all USB-C ports on the computer, in both orientations.</p> <p>Run AST 2 Full System diagnostic suites (EFI & OS), if available, to ensure no other issues remain.</p> <p>Is the issue resolved?</p>	Yes	The issue is resolved. Verify resolution.	\${nodeText.yesSymptomCode}	
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	

Flash Storage Not Recognized, Not Mounting, or Read/Write Issues

Unlikely causes:

Bottom case, display assembly, duckhead, eDP flex cable, fans, keyboard flex cable, I/O boards, audio board, power adapter, top case assembly, USB-C charging cable, vent/antenna module.

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">Starts up to a black screen with Apple logo.Displays a flashing folder with question mark or prohibitory symbol.Cannot save documents.Displays read/write error messages.Not responding when accessing or saving data. <p>Note: Inform the user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw.</p> <p>Important: Always ask if the user's data has been backed up before beginning the repair.</p> <ol style="list-style-type: none">Disconnect all peripherals and attempt to start up the computer.To restore the default startup disk, reset the NVRAM using the procedure for this computer in HT204063: Reset NVRAM or PRAM on your Mac.Reset the SMC using the procedure listed for this computer in HT201295: Reset the System Management Controller (SMC) on your Mac.

Deep Dive

	Check	Result	Action	Code	Commodity
1.	Use one of the following two methods to start up the computer to a known-good macOS.	Yes	Go to step 2.	\$(nodeText.yesSymptomCode)	
	<p>Start up the computer to macOS Recovery. See HT201314: About macOS Recovery.</p> <p>Follow steps in HT208198: About Startup Security Utility to enable starting up from an external storage device on the user's computer. Then start up the computer to a known-good external macOS startup volume.</p> <p>During startup, allow up to four minutes for a defective flash storage to time out, after which the computer will start up from a known-good external device.</p> <p>Does the computer start up from a known-good volume?</p>	No	Go to the "Will Not Start Up" troubleshooting flow.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
2.	<p>Run AST 2 Storage diagnostic test suite on the user's computer and examine the results of the test.</p> <p>Do all internal drive tests pass?</p>	Yes	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	M99	
		No	Go to step 3.	\$(nodeText.noSymptomCode)	
3.	<p>Examine AST 2 Storage diagnostic test suite results for presence of an internal drive.</p> <p>Does the computer pass or fail drive presence test?</p>	Pass	Go to step 4.	\$(nodeText.yesSymptomCode)	
		Fail	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M43	MLB
4.	<p>Examine diagnostic results for SMART status.</p> <p>Does the computer pass or fail SMART test?</p>	Pass	Go to step 5.	\$(nodeText.yesSymptomCode)	
		Fail	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M43	MLB

	Check	Result	Action	Code	Commodity
5.	Examine diagnostic results for Short Random Multi-Block Read Test. Does the computer pass or fail Short Random Multi-Block Read Test?	Pass	Go to step 6.	\$(nodeText.yesSymptomCode)	
		Fail	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M45	MLB
6.	Examine diagnostic results for File System Check. Does the computer pass or fail File System Check?	Pass	Go to step 7.	\$(nodeText.yesSymptomCode)	
		Fail	Go to step 9.	\$(nodeText.noSymptomCode)	
7.	Examine diagnostic results for Bootable Volume Presence Check. Does the computer pass or fail Bootable Volume Check?	Pass	Go to step 8.	\$(nodeText.yesSymptomCode)	
		Fail	Go to step 9.	\$(nodeText.noSymptomCode)	
8.	Examine diagnostic results for Last OS Reinstall Check. Does the computer pass or fail Last OS Reinstall Check?	Pass	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	M99	
		Fail	Go to step 9.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
9.	Use one of the following two methods to start up the computer to a known-good macOS.	Yes	Go to step 10.	\$(nodeText.yesSymptomCode)	
	<p>Start up the computer to macOS Recovery. See HT201314: About macOS Recovery</p> <p>Follow steps in HT208198: About Startup Security Utility to enable starting up from an external storage device on the user's computer. Then start up the computer to a known-good external macOS startup volume.</p> <p>Use Disk Utility to repair the user's internal flash storage volume.</p> <p>Attempt to start up the user's computer from its internal flash storage.</p> <p>Does the computer start up successfully from its internal flash storage?</p>	No	Go to step 11.	\$(nodeText.noSymptomCode)	
10.	<p>Run AST 2 Storage diagnostic test suite on the user's computer again and examine the results of the test.</p> <p>Does the computer pass all internal drive tests?</p>	Yes	The issue was resolved by repairing the flash storage volume. Verify resolution	\$(nodeText.yesSymptomCode)	
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	M99	

	Check	Result	Action	Code	Commodity
11.	<p>Start up the computer to macOS Recovery or a known-good external macOS startup volume. Run Disk Utility and select the user's flash storage drive.</p> <p>Erase the flash storage drive using Mac OS Extended (Case-sensitive, Journaled) format and GUID Partition Map scheme.</p> <p>Erase the flash storage drive again using Mac OS Extended (Journaled) format and GUID Partition Map scheme.</p> <p>Formatting the drive twice with different partition map schemes will force a rewrite of the partitions table.</p> <p>Refer to HT204743: Partition a problematic drive two times before recommending service or replacement for more information.</p> <p>Reinstall macOS on the user's computer.</p> <p>Check for and apply the latest software and firmware updates.</p> <p>Does the computer start up successfully from its internal flash storage?</p>	Yes	Go to step 10.	\$(nodeText.yesSymptomCode)	MLB
		No	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M44	
12.	<p>Confirm that computer can successfully start up from internal flash storage.</p> <p>Is issue resolved?</p>	Yes	The issue is resolved. Verify resolution.	\$(nodeText.yesSymptomCode)	
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	M99	

Burning Smell or Odor

Unlikely causes:

There are no unlikely causes for this issue.

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">Computer or power adapter emits a burning, smoky, or other unusual odor. <p>Note: Inform the user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw.</p> <ol style="list-style-type: none">Disconnect the power adapter and any peripherals from the computer.Inspect the enclosure and components for obvious signs of burning or smoky residue. Check the rear vents, keyboard, slots, and ports, as well as the power adapter, USB-C connector, and charging cable.Clean the enclosure to eliminate any causes due to external contamination.Verify that the vents allow unobstructed airflow into and out of the computer.

Deep Dive

	Check	Result	Action	Code	Commodity
1.	Determine whether this is a safety issue.	Yes	ESCALATION REQUIRED.	X99	
	Do not perform procedures that can be a safety risk to you or the user.		Contact CSS for safety-related issues. Refer to article OP44: Handling Potential Product Safety Issues .		
	Have you identified a safety issue?	No	Go to step 2.	\$(nodeText.noSymptomCode}	
2.	An odor can be related to external contamination. Inspect the computer exterior for contamination or lack of cleanliness.	Yes	Go to step 3.	\$(nodeText.yesSymptomCode}	
	Can you determine that the odor is caused by external contamination?	No	Go to step 4.	\$(nodeText.noSymptomCode}	
3.	Thoroughly clean enclosure and all external surfaces. Refer to HT204172: How to clean your Apple products . Explain the cause to the user.	Yes	The issue is resolved. Verify resolution.	\$(nodeText.yesSymptomCode}	
	Does user agree that the odor is due to external contamination?	No	ESCALATION REQUIRED. Contact CSS for additional support or a multipart repair.	X99	

	Check	Result	Action	Code	Commodity
4.	<p>Odors can be related to product newness. Refer to HT202324: Odors may be present short-term.</p> <p>Can you determine that the odor is due to the product being new?</p>	Yes	Go to step 5.	\$(nodeText.yesSymptomCode)	
		No	Go to step 6.	\$(nodeText.noSymptomCode)	
5.	<p>Explain to the user that new computers can sometimes emit an odor, similar to odors generated from new carpeting or a new car. In most cases, the odor dissipates after a brief period.</p> <p>Does the user agree that the odor is related to the computer being new?</p>	Yes	The issue is resolved. Verify resolution.	\$(nodeText.yesSymptomCode)	
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	
6.	<p>Closely inspect internal components and the enclosure for indications of physical damage or contamination.</p> <p>Can you identify signs of internal damage or contamination?</p>	Yes	Go to the “Mechanical/Physical/Cosmetic Damage” troubleshooting flow.	\$(nodeText.yesSymptomCode)	
		No	Go to step 7.	\$(nodeText.noSymptomCode)	
7.	<p>Refer to TP1150: Visual/Mechanical Inspection (VMI) Guide for Mac Liquid Damage for guidance regarding possible liquid damage to the user’s computer.</p> <p>Does the computer exhibit this type of damage?</p>	Yes	Go to the “Mechanical/Physical/Cosmetic Damage” troubleshooting flow.	\$(nodeText.yesSymptomCode)	
		No	Go to step 8.	\$(nodeText.noSymptomCode)	
8.	<p>Closely inspect internal hardware and the enclosure for other possible causes of odor, such as bulging or vented chip capacitors, or visible residue or burn marks on the enclosure, logic board, or other components.</p> <p>Have you identified a component failure as the source of the odor?</p>	Yes	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	
		No	The issue cannot be duplicated.	\$(nodeText.noSymptomCode)	
9.	<p>Run the computer for several hours and monitor for the issue/odor. Run the full system diagnostics available in AST 2. If no functional failure is detected, use correct positioning to explain to the user that the odor is related to external contamination or the newness of the computer.</p> <p>Is the issue resolved?</p>	Yes	The issue is resolved.	\$(nodeText.yesSymptomCode)	
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	

Computer Runs Hot

Unlikely causes:

Bottom case, display assembly, AC wall adapter, eDP flex cable, fans, keyboard flex cable, I/O boards, audio board, power adapter, top case assembly, USB-C charging cable, vent/antenna module

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">• Computer feels unusually warm.• Fans not operating.• Fans not functioning at full capacity.• Fans run constantly at high speeds. <p>Note: Inform the user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to article OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw.</p> <ol style="list-style-type: none">1. Run Mac Resource Inspector (MRI) to verify correct sensor operation.2. Check for and apply the latest software and firmware updates.3. Verify the temperature issue with the computer resting on a hard, flat surface. Note: Use this opportunity to educate the user about inappropriate work surfaces that may cause the computer to overheat. Refer to article HT201640: Keep your Mac notebook within acceptable operating temperatures.4. Compare the computer's operating temperature to a known-good, similarly configured computer.5. Check for runaway applications using the information in HT203184: See how apps affect Mac performance, battery runtime, temperature, and fan activity. Follow the instructions to halt any processes that are using excessive system resources.6. Processor-intensive or graphics-intensive applications and system processes may cause the bottom case to feel warm. Use Activity Monitor to identify these types of applications and explain the issue to the user.7. Reset the SMC using the procedure listed for this computer in HT201295: Reset the System Management Controller (SMC) on your Mac.

Deep Dive

	Check	Result	Action	Code	Commodity
1.	While connected to the user's power adapter and charging cable, run MRI via AST 2 to gather diagnostic information about the computer.	Yes	Go to step 2.	<code>\$(nodeText.yesSymptomCode)</code>	
	MRI will report a failure if any sensors are not detected or are exceeding expected thermal values.	No	Go to step 3.	<code>\$(nodeText.noSymptomCode)</code>	
	Does the computer pass all MRI checks?				

	Check	Result	Action	Code	Commodity
2.	Run CSD via AST 2. CSD works like a stress test on the computer, gathering information about the thermal performance while various components are under heavy use. Does the computer pass all CSD checks?	Yes	The computer passed all thermal checks and is operating within specifications. Verify correct operation and refer the customer to HT201640: Keep your Mac notebook within acceptable operating temperatures.	`\${nodeText.yesSymptomCode}`	
		No	Go to step 3.	`\${nodeText.noSymptomCode}`	
3.	Check diagnostic results for thermal sensor errors, which include sensor codes: <ul style="list-style-type: none"> • Ts0P • Ts1P Did diagnostics report any trackpad thermal sensor (Ts0P, Ts1P) errors?	Yes	Go to step 4.	`\${nodeText.yesSymptomCode}`	
		No	Go to step 12.	`\${nodeText.noSymptomCode}`	
4.	Inspect the keyboard flex cable and its connectors on the logic board and top case, looking for connector or cable damage. Check for a damaged connector or bent pins that prevent correct seating. Did you find damage to the keyboard flex cable or connectors?	Yes	Go to step 5.	`\${nodeText.yesSymptomCode}`	
		No	Go to step 6.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
5.	<p>Determine whether the damage is located on the keyboard flex cable, the logic board, or both.</p> <p>Is the damage limited to the keyboard flex cable?</p>	Yes	<p>Replace keyboard flex cable.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	X03	INTERNAL CABLE
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	P99	
6.	<p>Carefully reseal the keyboard flex cable into the connectors on the logic board and top case.</p> <p>Reassemble the computer and run diagnostics again.</p> <p>Do diagnostics still report the sensor failure?</p>	Yes	Go to step 7.	<p> <code> \${nodeText.yesSymptomCode} </code> </p>	
		No	The issue is resolved. Verify resolution.	<p> <code> \${nodeText.noSymptomCode} </code> </p>	
7.	<p>Inspect the trackpad flex cable and its connectors on the logic board and top case, looking for connector or cable damage. Check for a damaged connector or bent pins that prevent correct seating.</p> <p>Did you find damage to the trackpad flex cable or connectors?</p>	Yes	Go to step 8.	<p> <code> \${nodeText.yesSymptomCode} </code> </p>	
		No	Go to step 9.	<p> <code> \${nodeText.noSymptomCode} </code> </p>	

	Check	Result	Action	Code	Commodity
8.	<p>Determine whether the damage is located on the trackpad flex cable, the logic board, or both.</p> <p>Is the damage limited to the trackpad flex cable?</p>	Yes	<p>Replace the top case assembly with keyboard and trackpad.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K85	KEYBOARD
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	P99	
9.	Carefully reseal the trackpad flex cable into the connectors on the logic board and top case.	Yes	Go to step 10.	\${nodeText.yesSymptomCode}	
	<p>Reassemble the computer and run diagnostics again.</p> <p>Do diagnostics still report the sensor failure?</p>	No	The issue is resolved. Verify resolution.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
10.	<p>Troubleshooting this issue completely requires a known-good top case with keyboard and trackpad.</p> <p>Do you have immediate access to a known-good top case with keyboard and trackpad?</p>	Yes	Go to step 11.	\${nodeText.yesSymptomCode}	
		No	<p>Replace the top case assembly with keyboard and trackpad.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K85	KEYBOARD

	Check	Result	Action	Code	Commodity
11.	<p>Substitute a known-good top case with keyboard and trackpad.</p> <p>Reassemble the computer and run diagnostics again.</p> <p>Do diagnostics still report the sensor failure?</p>	Yes	<p>Reinstall the user's top case with keyboard and trackpad.</p> <p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M23	MLB
		No	<p>Replace the top case assembly with keyboard and trackpad.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K85	KEYBOARD
12.	<p>Check diagnostic results for thermal sensor errors, which include sensor codes:</p> <ul style="list-style-type: none"> • TB0T • TB1T • TB2T <p>Did diagnostics report any battery thermal sensor (TB0T, TB1T, TB2T) errors?</p>	Yes	Go to step 13.	<p> $\text{\\$}\{\text{nodeText.yesSymptomCode}\}$ </p>	
		No	Go to step 15.	<p> $\text{\\$}\{\text{nodeText.noSymptomCode}\}$ </p>	

	Check	Result	Action	Code	Commodity
13.	<p>Troubleshooting this issue completely requires a known-good top case with keyboard and trackpad.</p> <p>Do you have immediate access to a known-good top case with keyboard and trackpad?</p>	Yes	Go to step 14.	\${nodeText.yesSymptomCode}	
		No	<p>Replace the top case assembly with keyboard and trackpad.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K85	KEYBOARD

	Check	Result	Action	Code	Commodity
14.	Substitute a known-good top case with keyboard and trackpad. Reassemble the computer and run diagnostics again.	Yes	<p>Reinstall the user's top case with keyboard and trackpad.</p> <p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M23	MLB
	Do diagnostics still report the sensor failure?	No	<p>Replace the top case assembly with keyboard and trackpad.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K85	KEYBOARD

	Check	Result	Action	Code	Commodity
15.	<p>A disconnected or nonfunctional fan will prevent proper cooling and cause thermal sensors to exceed expected values.</p> <p>Check diagnostic results for airflow thermal sensor errors, which include sensor codes:</p> <ul style="list-style-type: none"> • TaLC • TaRC <p>Did diagnostics report any fan-related thermal sensor errors, or a fan motor test failure?</p>	Yes	Go to step 16.	\${nodeText.yesSymptomCode}	
		No	Go to step 22.	\${nodeText.noSymptomCode}	
16.	<p>Follow Service Guide procedures to remove the bottom case and disconnect the battery from the logic board.</p> <p>Disconnect both fan flex cable connectors and inspect top case and cable connector pins for damage.</p> <p>Inspect both fan flex cables and their connectors on the top case, looking for connector or cable damage. Check for a damaged connector or bent pins that prevent correct seating.</p> <p>Repeat for both left and right fans.</p> <p>Did you find damage to either fan flex cable or connector?</p>	Yes	Go to step 17.	\${nodeText.yesSymptomCode}	
		No	Go to step 18.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
17.	<p>Determine whether the damage is located on the fan flex cable, the top case, or both.</p> <p>Is the damage limited to the fan flex cable?</p>	Yes	<p>Replace affected fan.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	X22	OTHER ELECTRIC
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	P99	
18.	Carefully reseal both fan flex cables into their connectors.	Yes	Go to step 19.	\${nodeText.yesSymptomCode}	
	<p>Reassemble the computer and run diagnostics again.</p> <p>Do diagnostics still report a fan failure?</p>	No	<p>Issue resolved by reseating fan. Verify resolution.</p>	\${nodeText.noSymptomCode}	
19.	Remove both fans to reveal inner side of heat sink. Use an ESD-safe vacuum to remove dust and debris from heat sink.	Yes	Go to step 20.	\${nodeText.yesSymptomCode}	
	<p>Reassemble the computer and run diagnostics again.</p> <p>Do diagnostics still report a fan failure?</p>	No	<p>Issue resolved by reseating fan. Verify resolution.</p>	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
20.	<p>Continuing to troubleshoot this issue requires a known-good left or right fan (whichever is affected).</p> <p>Do you have immediate access to known-good fan?</p>	Yes	Go to step 21.	\${nodeText.yesSymptomCode}	
		No	<p>Replace affected fan.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	X22	OTHER ELECTRIC

	Check	Result	Action	Code	Commodity
21.	<p>Substitute a known-good fan.</p> <p>Reassemble the computer and run diagnostics again.</p> <p>Do diagnostics still report a fan failure?</p>	Yes	<p>Reinstall the user's fans.</p> <p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M18	MLB
		No	<p>Replace affected fan.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	X22	OTHER ELECTRIC

	Check	Result	Action	Code	Commodity
22.	<p>Check diagnostic results for failures related to any other logic board thermal sensor errors, which include sensor codes:</p> <p>TC0P, TC1C, TC2C, TC3C, TC4C, TCGC, TCMX, TCSA, TCXC, TH0A, TH0B, TH0C, Th1H, Th2H, TM0P, TPCD</p> <p>Did diagnostics report any thermal interface or logic board thermal sensor errors?</p>	Yes	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M23	MLB
		No	<p>The computer passed all thermal checks, and is operating within specifications. Verify correct operation and refer the customer to HT201640: Keep your Mac notebook within acceptable operating temperatures.</p> <p>If the diagnostic is reporting other errors, select a different symptom based on the diagnostic results.</p>	\${nodeText.noSymptomCode}	
23.	<p>Use Cooling System Diagnostic to verify that the computer is running within thermal specifications.</p> <p>Is the issue resolved?</p>	Yes	The issue is resolved.	\${nodeText.yesSymptomCode}	
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	

Mechanical, Physical, or Cosmetic Damage

Unlikely causes:

There are no unlikely causes for this issue.

Quick Check

Symptoms	Quick Check
<p>The computer shows signs of physical and/or cosmetic damage such as:</p> <p>Enclosure:</p> <ul style="list-style-type: none">Loose or broken hingesStripped, loose, or missing screwLiquid spill <p>Display Assembly:</p> <ul style="list-style-type: none">Cracked or broken display frame and/or assembly housingScratchesDentsLiquid spill <p>Keyboard and Top Case:</p> <ul style="list-style-type: none">Worn paint on one or more keys on the built-in keyboardScratchesDentsLiquid spill <p>AC Power Adapter:</p> <ul style="list-style-type: none">Mechanical damage to adapter connector, cable, or housingScratchesDentsLiquid spill <p>Note: Inform the user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to article OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw.</p> <ol style="list-style-type: none">Inspect the computer and discuss the nature of the issue with the user. Determine whether the user wants to proceed with the repair (despite possible accidental damage) or pursue other service options. Click “No” to proceed with further troubleshooting.Refer to TP1151: Visual/Mechanical Inspection (VMI) Guide for Mac Computers for guidance regarding possible damage to the user’s computer.Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.

Deep Dive

	Check	Result	Action	Code	Commodity
1.	Determine the cause of damage or defects: user, technician, environment, accidental damage, or abuse.	Yes	ESCALATION REQUIRED. Contact CSS for assistance with Apple-related accidental damage.	X99	
	Is an Apple technician responsible for the damage or defect on the computer?	No	Go to step 2.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
2.	<p>Closely examine the user's computer for signs of enclosure damage such as:</p> <ul style="list-style-type: none"> • Hinges are loose or broken. • Screw is stripped, loose, or missing. <p>Does the computer exhibit this type of damage?</p>	Yes	<p>Proceed with repair creation to see available options. Inform the user that computer failures due to accidental damage are not covered by Apple's one-year limited warranty or the AppleCare Protection Plan (APP).</p> <p>Refer to www.apple.com/legal/warranty for details.</p>	X12	ENCLOSURE
		No	Go to step 3.	\$(nodeText.noSymptomCode)	
3.	<p>Closely examine the user's computer for signs of enclosure damage such as:</p> <ul style="list-style-type: none"> • Scratches • Dents • Cracks <p>Does the computer exhibit this type of damage?</p>	Yes	<p>Proceed with repair creation to see available options. Inform the user that computer failures due to accidental damage are not covered by Apple's one-year limited warranty or the AppleCare Protection Plan (APP).</p> <p>Refer to www.apple.com/legal/warranty for details.</p>	X13	ENCLOSURE
		No	Go to step 4.	\$(nodeText.noSymptomCode)	
4.	<p>Closely examine the user's computer enclosure for signs of liquid spill damage.</p> <p>Look for any signs of liquid spill, liquid penetration, or liquid damage to the computer's enclosure.</p> <p>Does the computer exhibit this type of damage?</p>	Yes	<p>Proceed with repair creation to see available options. Inform the user that computer failures due to accidental damage are not covered by Apple's one-year limited warranty or the AppleCare Protection Plan (APP).</p> <p>Refer to www.apple.com/legal/warranty for details.</p>	X90	ENCLOSURE
		No	Go to step 5.	\$(nodeText.noSymptomCode)	
5.	<p>Closely examine the user's computer for signs of display assembly damage, such as a cracked or broken display frame and/or assembly housing.</p> <p>Note: For cracked display glass issues, return to the list of symptoms and select the "Cracked Display" troubleshooting flow.</p> <p>Does the computer exhibit this type of damage?</p>	Yes	<p>Proceed with repair creation to see available options. Inform the user that computer failures due to accidental damage are not covered by Apple's one-year limited warranty or the AppleCare Protection Plan (APP).</p> <p>Refer to www.apple.com/legal/warranty for details.</p>	L18	LCD
		No	Go to step 6.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
6.	<p>Closely examine the user's computer display assembly for signs of cosmetic damage, such as:</p> <ul style="list-style-type: none"> Scratches Dents <p>Does the computer exhibit this type of damage?</p>	Yes	<p>Proceed with repair creation to see available options. Inform the user that computer failures due to accidental damage are not covered by Apple's one-year limited warranty or the AppleCare Protection Plan (APP).</p> <p>Refer to www.apple.com/legal/warranty for details.</p>	L19	LCD
		No	Go to step 7.	\$(nodeText.noSymptomCode)	
7.	<p>Closely examine the user's computer display assembly for signs of liquid spill damage.</p> <p>Look for any signs of liquid spill, liquid penetration, or liquid damage to the computer's display assembly.</p> <p>Does the computer exhibit this type of damage?</p>	Yes	<p>Proceed with repair creation to see available options. Inform the user that computer failures due to accidental damage are not covered by Apple's one-year limited warranty or the AppleCare Protection Plan (APP).</p> <p>Refer to www.apple.com/legal/warranty for details.</p>	L90	LCD
		No	Go to step 8.	\$(nodeText.noSymptomCode)	
8.	<p>Closely examine the user's computer keyboard and top case for signs of cosmetic damage such as:</p> <ul style="list-style-type: none"> Scratches Dents <p>Does the computer exhibit this type of damage?</p>	Yes	<p>Proceed with repair creation to see available options. Inform the user that computer failures due to accidental damage are not covered by Apple's one-year limited warranty or the AppleCare Protection Plan (APP).</p> <p>Refer to www.apple.com/legal/warranty for details.</p>	K21	KEYBOARD
		No	Go to step 9.	\$(nodeText.noSymptomCode)	
9.	<p>Closely examine the user's computer keyboard and top case for signs of cosmetic damage such as:</p> <ul style="list-style-type: none"> Paint is wearing off of one or more keys on the built-in keyboard. <p>Does the computer exhibit this type of damage?</p>	Yes	<p>Proceed with repair creation to see available options. Inform the user that computer failures due to accidental damage are not covered by Apple's one-year limited warranty or the AppleCare Protection Plan (APP).</p> <p>Refer to www.apple.com/legal/warranty for details.</p>	K35	KEYBOARD
		No	Go to step 10.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
10.	<p>Closely examine the user's computer keyboard and top case for signs of liquid spill damage.</p> <p>Look for any signs of liquid spill, liquid penetration, or liquid damage to the computer's keyboard and top case.</p>	Yes	<p>Proceed with repair creation to see available options. Inform the user that computer failures due to accidental damage are not covered by Apple's one-year limited warranty or the AppleCare Protection Plan (APP).</p> <p>Refer to www.apple.com/legal/warranty for details.</p>	K90	KEYBOARD
	Does the computer exhibit this type of damage?	No	Go to step 11.	\$(nodeText.noSymptomCode)	
11.	<p>Closely examine the user's AC power adapter for signs of connector damage such as:</p> <ul style="list-style-type: none"> • Pins stuck, broken, burnt, pushed in, or bent. 	Yes	<p>Proceed with repair creation to see available options. Inform the user that computer failures due to accidental damage are not covered by Apple's one-year limited warranty or the AppleCare Protection Plan (APP).</p> <p>Refer to www.apple.com/legal/warranty for details.</p>	P15	ADAPTER
	Does the AC power adapter exhibit this type of damage?	No	Go to step 12.	\$(nodeText.noSymptomCode)	
12.	<p>Closely examine the user's AC power adapter for signs of mechanical damage such as:</p> <ul style="list-style-type: none"> • Adapter connector and/or cable • Adapter housing 	Yes	<p>Proceed with repair creation to see available options. Inform the user that computer failures due to accidental damage are not covered by Apple's one-year limited warranty or the AppleCare Protection Plan (APP).</p> <p>Refer to www.apple.com/legal/warranty for details.</p>	P16	ADAPTER
	Does the AC power adapter exhibit this type of damage?	No	Go to step 13.	\$(nodeText.noSymptomCode)	
13.	<p>Closely examine the user's AC power adapter for signs of cosmetic damage such as:</p> <ul style="list-style-type: none"> • Scratches • Dents 	Yes	<p>Proceed with repair creation to see available options. Inform the user that computer failures due to accidental damage are not covered by Apple's one-year limited warranty or the AppleCare Protection Plan (APP).</p> <p>Refer to www.apple.com/legal/warranty for details.</p>	P21	ADAPTER
	Does the AC power adapter exhibit this type of damage?	No	Go to step 14.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
14.	<p>Closely examine the user's AC power adapter for signs of liquid spill damage.</p> <p>Look for any signs of liquid spill, liquid penetration, or liquid damage to the user's AC power adapter.</p> <p>Does the AC power adapter exhibit this type of damage?</p>	Yes	<p>Proceed with repair creation to see available options. Inform the user that computer failures due to accidental damage are not covered by Apple's one-year limited warranty or the AppleCare Protection Plan (APP).</p> <p>Refer to www.apple.com/legal/warranty for details.</p>	P90	ADAPTER
		No	Go to step 15.	\${nodeText.noSymptomCode}	
15.	<p>Closely examine the user's USB-C charging cable and connectors for damage.</p> <p>Refer to TP1520: Visual/Mechanical Inspection (VMI) Guide for Mac Portables USB-C Cables when inspecting the user's cable.</p> <p>Does the USB-C charge cable exhibit damage according to the VMI?</p>	Yes	<p>Proceed with repair creation to see available options. Inform the user that computer failures due to accidental damage are not covered by Apple's one-year limited warranty or the AppleCare Protection Plan (APP).</p> <p>Refer to www.apple.com/legal/warranty for details.</p>	X03	EXTERNAL CABLE
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for assistance with Apple-related accidental damage.</p>	\${nodeText.noSymptomCode}	

Noise, Hum, or Vibration

Unlikely causes:

Bottom case, display assembly, AC wall adapter, eDP flex cable, keyboard flex cable, I/O boards, audio board, top case assembly, USB-C charging cable, vent/antenna module.

Quick Check

Symptoms	Quick Check
Computer or power adapter emits noise or vibration. Note: Inform user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables .	Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw. Note: Verify the issue after using the computer for a few minutes to warm it, or by following steps in HT207571: Warm a Mac for testing . Doing this may help identify intermittent issues. <ol style="list-style-type: none">1. Work with user to reproduce issue and isolate source of noise. Determine whether source of noise is computer or power adapter.2. If power adapter is source of noise, test with a known-good adapter. (A small amount of hum or vibration is normal for power adapters.)3. If necessary, explain to user that some noises are normal. Refer to article HT202179: About fans and fan noise in your Apple product.

Deep Dive

	Check	Result	Action	Code	Commodity
1.	Shut down the computer and let it cool off fully. Once the computer is cold, start it up and check for noise, hum, or vibration. Does issue persist during cold startup?	Yes	Go to step 2.	\$(nodeText.yesSymptomCode)	
		No	Go to step 11.	\$(nodeText.noSymptomCode)	
2.	An unreadable thermal sensor can cause a fan to run excessively. Run MRI to check thermal sensors. Does MRI report any thermal sensor failures?	Yes	Go to “Computer Runs Hot” troubleshooting flow.	\$(nodeText.yesSymptomCode)	
		No	Go to step 3.	\$(nodeText.noSymptomCode)	
3.	Excessive fan operation may also occur if computer is unable to read fan speed. Check MRI results for fan (motor) sensor test results. Does MRI report any fan (motor) failures?	Yes	Go to step 5.	\$(nodeText.yesSymptomCode)	
		No	Go to step 4.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
4.	<p>Disconnect the left fan and briefly retest for noise, hum, or vibration.</p> <p>Disconnect the right fan and briefly retest for noise, hum, or vibration.</p> <p>Has noise been eliminated?</p>	Yes	<p>Replace affected fan.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	X23	OTHER ELECTRIC
		No	Go to step 11.	\$(nodeText.noSymptomCode)	
5.	<p>Follow service guide procedures to remove the bottom case and disconnect the battery from the logic board.</p> <p>Disconnect both fan flex cable connectors and inspect top case and cable connector pins for damage.</p> <p>Inspect both fan flex cables and their connectors on the top case, looking for connector or cable damage. Check for a damaged connector or bent pins that prevent correct seating.</p> <p>Repeat for both left and right fans.</p> <p>Did you find damage to either fan flex cable or connector?</p>	Yes	Go to step 6.	\$(nodeText.yesSymptomCode)	
		No	Go to step 7.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
6.	<p>Determine whether the damage is located on the fan flex cable, the top case, or both.</p> <p>Is the damage limited to the fan flex cable?</p>	Yes	<p>Replace affected fan.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	X23	OTHER ELECTRIC
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	
7.	<p>Carefully reseal both fan flex cables into their connectors on the top case.</p> <p>Reassemble the computer and run diagnostics again.</p> <p>Do diagnostics still report a fan failure?</p>	Yes	Go to step 8.	\$(nodeText.yesSymptomCode)	
		No	<p>Issue resolved by resealing fan. Verify resolution.</p>	\$(nodeText.noSymptomCode)	
8.	<p>Remove both fans to reveal inner side of heat sink. Use an ESD-safe vacuum to remove dust and debris from heat sink.</p> <p>Reassemble the computer and run diagnostics again.</p> <p>Do diagnostics still report a fan failure?</p>	Yes	Go to step 9.	\$(nodeText.yesSymptomCode)	
		No	<p>Issue resolved by cleaning fan. Verify resolution.</p>	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
9.	<p>Continuing to troubleshoot this issue requires a known-good left or right fan (whichever is affected).</p> <p>Do you have immediate access to known-good fan?</p>	Yes	Go to step 10.	\${nodeText.yesSymptomCode}	
		No	<p>Replace affected fan.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	X23	OTHER ELECTRIC

	Check	Result	Action	Code	Commodity
10.	Substitute a known-good fan. Reassemble the computer and run diagnostics again.	Yes	Reinstall the user's fans. Replace the logic board and Touch ID board. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair. Verify that the issue is resolved.	M18	MLB
	Do diagnostics still report a fan failure?	No	Replace affected fan. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair. Verify that the issue is resolved.	X23	OTHER ELECTRIC
11.	Substitute a known-good power adapter and retest.	Yes	Replace power adapter. Verify that the issue is resolved.	P04	ADAPTER
	Has noise been eliminated?	No	Go to step 12.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
12.	Disconnect any peripheral devices, cards, or cables attached to computer. Has noise been eliminated?	Yes	Issue resolved. Issue caused by ground loop induced by third-party devices. Advise user to connect all devices to a common power outlet or contact device manufacturer for support.	\$(nodeText.yesSymptomCode)	
		No	Go to step 13.	\$(nodeText.noSymptomCode)	
13.	Noise may be related to interference from other electrical devices operating near computer or plugged into same power outlet. See if noise is eliminated when computer runs in a different location on a different circuit. Has noise been eliminated?	Yes	Issue resolved. Verify resolution.	\$(nodeText.yesSymptomCode)	
		No	ESCALATION REQUIRED. Contact CSS for additional support or a multipart repair.	X99	
14.	Verify that noise, hum, or vibration is resolved. There may be noise from fan and audio circuitry, but there should be no noise from the flash storage. If help is needed, record a sample audio file to review with CSS. Is issue resolved?	Yes	Issue resolved.	\$(nodeText.yesSymptomCode)	
		No	ESCALATION REQUIRED. Contact CSS for additional support or a multipart repair.	X99	

Battery Leaking or Swollen

Unlikely causes:

Bottom case, display assembly, AC wall adapter, eDP flex cable, fans, keyboard flex cable, I/O boards, logic board, audio board, power adapter, USB-C charging cable, vent/antenna module.

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">• One or more battery cells have increased in size• Computer wobbles and will not sit evenly on flat surface• Bottom case cannot be reinstalled <p>Note: Inform the user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw.</p> <ol style="list-style-type: none">1. Check for correct installation of bottom case. An expanded battery may be preventing complete installation of the bottom case cover.2. Refer to OP14: Determining and quoting accidental damage for Mac portables to check for causes that would prevent correct installation of the bottom case or battery.3. Refer to HT204762: Enclosure separation due to expanded battery.4. Follow the guidelines in OP693: MacBook Air (Late 2010 and later), MacBook Pro with Retina display computers: Visual battery inspection.5. Follow the guidelines in OP24: Safely handling lithium batteries and lithium battery-powered devices.

Deep Dive

	Check	Result	Action	Code	Commodity
1.	<p>Follow Service Guide procedures to remove the bottom case and disconnect the battery from the logic board.</p> <p>Inspect the battery for any sign of battery cell puncture, leakage, venting, or cell deformation.</p> <p>Refer to section five of OP24: Safely handling lithium batteries and lithium battery-powered devices, titled “Venting batteries.” Recognize battery cell electrolyte leakage.</p> <p>Apply a protective battery cover to the computer battery that is being serviced.</p> <p>If a battery cell is leaking:</p> <ol style="list-style-type: none"> 1. Keep all personnel at a safe distance to prevent persons from coming in contact with spilled material. 2. Eliminate all ignition sources and other debris (no heat sources, sparks, or flames in immediate area). <p>A leaking battery should only be handled by trained and properly equipped personnel.</p> <p>Are any battery cells punctured, leaking, or deformed?</p>	Yes	<p>Replace the top case assembly with keyboard and trackpad.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K33	KEYBOARD
		No	Go to step 2.	\$(nodeText.noSymptomCode}	
2.	<p>Check the battery and bottom case installation. Verify that the battery has not expanded to deform the enclosure or separate the bottom case and top case.</p> <p>One or more battery cells might have expanded, resulting in pressure on the bottom case cover.</p> <p>Refer to OP693: MacBook Air (Late 2010 and later), MacBook Pro with Retina display computers: Visual battery inspection.</p> <p>Place a protective battery cover on the computer being serviced.</p> <p>Has one or more battery cells expanded in size?</p>	Yes	Go to step 3.	\$(nodeText.yesSymptomCode}	
		No	Go to step 4.	\$(nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
3.	<p>Inspect the bottom case for deformation due to battery swelling.</p> <p>Check that the bottom case can be installed correctly on new top case.</p> <p>Replacement of multiple parts requires an escalation to CSS for repair approval.</p> <p>Is bottom case deformed and in need of replacement?</p>	Yes	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	P99	
		No	<p>Replace the top case assembly with keyboard and trackpad.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K33	KEYBOARD
4.	<p>Check with the user to determine whether battery runtime is shorter than usual.</p> <p>Is the user's battery experiencing shorter battery runtime?</p>	Yes	Go to the "Battery Runtime Too Short" troubleshooting flow.	\$(nodeText.yesSymptomCode)	
		No	Issue cannot be duplicated.	\$(nodeText.noSymptomCode)	
5.	<p>Run Mac Resource Inspector (MRI) and verify that the computer passes all tests, especially the battery diagnostics.</p> <p>Is issue resolved?</p>	Yes	The issue is resolved. Verify resolution.	\$(nodeText.yesSymptomCode)	
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	

Battery Not Recognized or Does Not Charge

Unlikely causes:

Bottom case, display assembly, AC wall adapter, eDP flex cable, fans, keyboard flex cable, audio board, vent/antenna module.

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">• “X” in battery status menu• No lightning bolt icon in battery status menu when power adapter is connected <p>Note: Inform user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw.</p> <ol style="list-style-type: none">1. Verify that you are using a functional power outlet.2. Verify that the user’s power adapter and charging cable are the correct models for the user’s computer. Refer to HT201700: Find the right power adapter and cable for your Mac notebook. Different power adapters and USB-C charging cables may appear similar but may not provide sufficient power to turn on or charge the computer.3. Check for damage or debris in the USB-C connectors on the computer and the power adapter.4. Inspect the power adapter, connectors, AC wall adapter, and charging cable for damage such as bent plug pins, frayed or exposed wiring, or burn marks.5. Test with a known-good electrical outlet, power source, and power adapter.6. Connect the power adapter to each USB-C connector on the computer and retest each time to isolate a possible faulty USB-C port on the user’s computer.7. Reset the NVRAM using the procedure for this computer in HT204063: How to Reset NVRAM or PRAM on your Mac.8. Reset the SMC using the procedure for this computer in HT201295: Reset the System Management Controller (SMC) on your Mac.9. Refer to HT201260: How to find the macOS version number on your Mac to check that the system build is correct for this computer model. Check for and apply the latest software and firmware updates.10. Refer to the following articles to learn more about power-related features and functions specific to this computer that may be misinterpreted as service issues:<ul style="list-style-type: none">• HT207097: Charge your MacBook Pro with Thunderbolt 3• HT207104: Start up your MacBook Pro or MacBook by opening it or plugging it in• HT204652: If your USB-C power adapter isn’t charging your Mac notebook• HT204700: Battery may not charge or drains while using AC power

Deep Dive

	Check	Result	Action	Code	Commodity
1.	<p>Connect the user's computer to the user's power adapter and charging cable that is connected to a known-good electrical outlet.</p> <p>The computer should turn on automatically if it is off when the power adapter is connected.</p> <p>Check System Information > Power > AC Charger Information to verify that the computer recognizes the power adapter.</p> <p>Does the computer recognize the power adapter?</p>	Yes	Go to step 2.	`\${nodeText.yesSymptomCode}`	
		No	Go to the "Power Adapter Issues" troubleshooting flow.	`\${nodeText.noSymptomCode}`	
2.	<p>While connected to the user's power adapter and charging cable, run Mac Resource Inspector (MRI) via AST 2 to gather diagnostic information about the battery.</p> <p>Check the results for a battery failure that states "no battery detected."</p> <p>Does the computer recognize the battery?</p>	Yes	Go to step 5.	`\${nodeText.yesSymptomCode}`	
		No	Go to step 3.	`\${nodeText.noSymptomCode}`	
3.	<p>Troubleshooting this issue completely requires a known-good top case assembly.</p> <p>Do you have immediate access to a known-good top case assembly?</p>	Yes	Go to step 4.	`\${nodeText.yesSymptomCode}`	
		No	<p>Replace the top case assembly with keyboard and trackpad.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K31	KEYBOARD

	Check	Result	Action	Code	Commodity
4.	Substitute a known-good top case assembly.	Yes	Replace the top case assembly with keyboard and trackpad.	K40	KEYBOARD
	Verify that the battery is recognized.		Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.		
	Does computer detect a known-good battery?	No	Verify that the issue is resolved.	M20	MLB
			Reinstall the user's top case assembly.		
5.	While connected to the user's power adapter and charging cable, run MRI via AST 2 to gather diagnostic information about the battery.	Yes	Replace the logic board and Touch ID board.	{nodeText.yesSymptomCode}	
	Check the results for any battery-specific warnings or failures.	No	Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.		
6.	Does MRI report any battery errors?	Yes	Go to step 7.	{nodeText.yesSymptomCode}	
			Go to step 6.		
	Run Power Adapter diagnostics.	Yes	Go to the "Power Adapter Issues" troubleshooting flow.	{nodeText.yesSymptomCode}	
	Power Adapter diagnostics may report a faulty power adapter, which could cause short battery runtimes.		There is no hardware issue with the battery or power adapter. Proceed with software troubleshooting. Recommend that the user refer to www.apple.com/batteries for tips to maximize battery life.		
	Does Power Adapter diagnostics report a power adapter failure?	No		{nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
7.	Check MRI results for a consumed-battery error. Does MRI report a consumed battery?	Yes	The battery is consumed. Advise the user that consumed batteries are not covered under the Apple warranty. Replace the top case assembly with keyboard and trackpad. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair. Verify that the issue is resolved.	K41	KEYBOARD
		No	Go to step 8.	\$(nodeText.noSymptomCode)	
8.	Check the MRI results for failed (defective) battery error. Does MRI report a failed battery?	Yes	Replace the top case assembly with keyboard and trackpad. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair. Verify that the issue is resolved.	K41	KEYBOARD
		No	ESCALATION REQUIRED. Contact CSS for additional support or a multipart repair.	P99	

	Check	Result	Action	Code	Commodity
9.	Verify that battery is properly charging. Charge the battery for some time. Then run the computer from the battery for only a few minutes. Reconnect the power adapter and verify that the computer correctly detects the adapter and charges the battery.	Yes	The issue is resolved.	\${nodeText.yesSymptomCode}	
	Run MRI and other applicable diagnostics to check for any other issues. Is the issue resolved?	No	ESCALATION REQUIRED. Contact CSS for additional support or a multipart repair.	X99	

Battery Runtime Too Short

Unlikely causes:

Bottom case, display assembly, duckhead, eDP flex cable, fans, keyboard flex cable, I/O boards, logic board, audio board, power adapter, USB-C charging cable, vent/antenna module.

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">Battery runs out of power very quickly (in less than two hours).Battery runs out of power without any warning.Battery menu displays messages such as Service Battery, Replace Now, or Replace Soon. <p>Note: Inform the user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw.</p> <ol style="list-style-type: none">Verify that the user's power adapter and charging cable are the correct models for the user's computer. Refer to HT201700: Find the right power adapter and cable for your Mac notebook. Different power adapters and USB-C charging cables may appear similar but may not provide sufficient power to turn on or charge the computer.Refer to HT201260: How to find the macOS version number on your Mac to check that the system build is correct for this computer model.Verify that applications are not forcing CPU or GPU to work overtime and consume unnecessary battery power. Refer to HT203184: See how apps affect Mac performance, battery runtime, temperature, and fan activity. To help extend battery performance, refer the user to HT204054: About Mac notebook batteries.Inspect the power adapter, connectors, AC wall adapter, and charging cable for damage such as bent plug pins, frayed or exposed wiring, or burn marks.Run AST 2 Power Adapter diagnostics with the user's power adapter connected to a known-good computer to confirm that the power adapter is functioning.Run AST 2 Power Adapter diagnostics with a known-good power adapter connected to the user's computer to confirm that the computer is functioning.Refer to the following articles to learn more information about power-related features and functions specific to this computer that may be misinterpreted as service issues:<ul style="list-style-type: none">HT207097: Charge your MacBook Pro with Thunderbolt 3HT207104: Start up your MacBook Pro or MacBook by opening it or plugging it inHT204652: If your USB-C power adapter isn't charging your Mac notebookHT204700: Battery may not charge or drains while using AC power

Deep Dive

	Check	Result	Action	Code	Commodity
1.	While connected to the user's power adapter and charging cable, run Mac Resource Inspector (MRI) via AST 2 to gather diagnostic information about the battery.	Yes	Go to step 3.	`\${nodeText.yesSymptomCode}`	
	Check the results for any battery-specific warnings or failures. Does MRI report any battery errors?	No	Go to step 2.	`\${nodeText.noSymptomCode}`	
2.	Run Power Adapter diagnostics.	Yes	Go to the "Power Adapter Issues" troubleshooting flow.	`\${nodeText.yesSymptomCode}`	
	Power Adapter diagnostics may report a faulty power adapter, which could cause short battery runtimes. Did Power Adapter diagnostics report a power adapter failure?	No	There is no hardware issue with the battery or power adapter. Proceed with software troubleshooting. Recommend that the user refer to www.apple.com/batteries for tips to maximize battery life.	`\${nodeText.noSymptomCode}`	
3.	Check MRI results for a consumed battery error. Does MRI report a consumed battery?	Yes	<p>The battery is consumed.</p> <p>Advise the user that consumed batteries are not covered under the Apple warranty.</p> <p>Replace the top case assembly with keyboard and trackpad.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K32	KEYBOARD
		No	Go to step 4.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
4.	<p>Check the MRI results for a failed (defective) battery error.</p> <p>Does MRI report a failed battery?</p>	Yes	<p>Replace the top case assembly with keyboard and trackpad.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K32	KEYBOARD
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	P99	
5.	<p>Verify that battery runtime falls within specification.</p> <p>Run MRI and any other applicable diagnostics to check for any other issues.</p> <p>Is the issue resolved?</p>	Yes	The issue is resolved.	\${nodeText.yesSymptomCode}	
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	

Does Not Run on Power Adapter

Unlikely causes:

Bottom case, display assembly, eDP flex cable, fans, keyboard flex cable, audio board, vent/antenna module.

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">• Computer runs on battery, but not on power adapter alone. <p>Note: Inform the user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Disable Auto Boot before performing any troubleshooting steps that require disassembly of the computer, and reenable Auto Boot after the computer has been reassembled and service is completed. Follow steps in TP1484: Auto Boot to enable or disable this function.</p> <ol style="list-style-type: none">1. Verify that you are using a functional power outlet.2. Verify that the user's power adapter and charging cable are the correct models for the user's computer. Refer to HT201700: Find the right power adapter and cable for your Mac notebook. Different power adapters and USB-C charging cables may appear similar but may not provide sufficient power to turn on or charge the computer.3. Check for damage or debris in the USB-C connectors on the computer and the power adapter.4. Inspect the power adapter, connectors, AC wall adapter, and charging cable for damage such as bent plug pins, frayed or exposed wiring, or burn marks.5. Test with a known-good electrical outlet, power source, and power adapter.6. Connect the power adapter to each USB-C connector on the computer and retest each time to isolate a possible faulty USB-C port on the user's computer.7. Reset the NVRAM using the procedure for this computer in HT204063: Reset NVRAM or PRAM on your Mac.8. Reset the SMC using the procedure for this computer in HT201295: How to reset the System Management Controller (SMC) on your Mac. Retest for power issues.9. Refer to HT201260: Find out which macOS your Mac is using to check that the system build is correct for this computer model.10. Refer to the following articles to learn more about power-related features and functions specific to this computer that may be misinterpreted as service issues:<ul style="list-style-type: none">• HT207097: Charge your MacBook Pro with Thunderbolt 3• HT201150: How to turn your Mac on or off• HT204652: If your USB-C power adapter isn't charging your Mac notebook• HT204700: Battery may not charge or drains while using AC power

Deep Dive

	Check	Result	Action	Code	Commodity
1.	<p>Inspect all USB-C ports and top case openings on the user's computer for any signs of deformation, damage, or debris that may be blocking the connection. Use compressed air to clear any obstructions or debris.</p> <p>Important: Do not use any metal objects to clear debris or obstructions, as this can short the connector and cause damage.</p> <p>Is any USB-C port damaged?</p>	Yes	Go to step 2.	\$(nodeText.yesSymptomCode}	
		No	Go to step 3.	\$(nodeText.noSymptomCode}	
2.	<p>Inspect the opening on the top case for the USB-C port. Determine whether the opening is misshapen or deformed, preventing proper insertion of the USB plugs.</p> <p>Is the opening for the USB-C port damaged or deformed?</p>	Yes	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K16	KEYBOARD
		No	<p>Replace the damaged left or right I/O board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M24	OTHER BOARD

	Check	Result	Action	Code	Commodity
3.	<p>Connect the user's computer to a known-good Apple USB-C power adapter with a known-good Apple USB-C charging cable that is the correct type for the user's computer.</p> <p>Connect the power adapter to a known-good electrical outlet.</p> <p>Check that the computer recognizes the power adapter.</p> <p>The computer should turn on automatically if it is off when the power adapter is connected.</p> <p>Verify in System Information > Power > AC Charger Information that the computer recognizes the power adapter.</p> <p>Does the computer recognize the power adapter, turn on, and begin to charge?</p>	Yes	Go to step 4.	\$(nodeText.yesSymptomCode)	
		No	Go to step 5.	\$(nodeText.noSymptomCode)	
4.	<p>Shut down the computer.</p> <p>Disconnect and flip the orientation of the USB-C charging cable plug, then reconnect it to the same USB-C port on the computer and retest, to test both orientations.</p> <p>The computer should turn on automatically.</p> <p>Verify in System Information > Power > AC Charger Information that the computer recognizes the power adapter.</p> <p>Does the computer recognize the power adapter turn on?</p>	Yes	Go to the "Power Adapter Issues" troubleshooting flow.	\$(nodeText.yesSymptomCode)	
		No	Go to step 5.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
5.	Follow Service Guide procedures to remove the bottom case and disconnect the battery from the logic board.	Yes	Issue resolved by reseating affected I/O board.	\$(nodeText.yesSymptomCode)	
	<p>Disconnect then reconnect affected I/O board (left or right) to reseat the connection to the logic board and reassemble the computer.</p> <p>Connect the user's computer to a known-good power adapter and charging cable that is connected to a known-good electrical outlet.</p> <p>The computer should turn on automatically if it is off when the power adapter is connected.</p> <p>Verify in System Information > Power > AC Charger Information that the computer recognizes the power adapter.</p> <p>Does the computer recognize the power adapter, turn on, and begin to charge?</p>	No	Go to step 6.	\$(nodeText.noSymptomCode)	
6.	<p>Troubleshooting this issue completely requires known-good left and right I/O boards.</p> <p>Do you have immediate access to known-good left and right I/O boards?</p>	Yes	Go to step 7.	\$(nodeText.yesSymptomCode)	
		No	<p>Replace the affected left or right I/O board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M21	OTHER BOARD

	Check	Result	Action	Code	Commodity
7.	<p>Substitute known-good left and right I/O boards and reassemble the computer.</p> <p>Connect the user's computer to a known-good power adapter and charging cable that is connected to a known-good electrical outlet.</p> <p>The computer should turn on automatically if it is off when the power adapter is connected.</p> <p>Verify in System Information > Power > AC Charger Information that the computer recognizes the power adapter.</p> <p>Does the computer recognize the power adapter, turn on, and begin to charge?</p>	Yes	<p>Replace the affected left or right I/O board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M21	OTHER BOARD
		No	<p>Reinstall the user's left and right I/O boards.</p> <p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M21	MLB
8.	<p>Verify that the computer can now detect the power adapter and that it is able to charge.</p> <p>Run AST 2 Full System diagnostic suites (EFI & OS), if available, to ensure no other issues remain.</p> <p>Is the issue resolved?</p>	Yes	The issue is resolved.	\$(nodeText.yesSymptomCode)	
		No	<p>ESCALATION REQUIRED.</p> <p>Contact ACS for additional support or a multipart repair.</p>	X99	

Intermittent Shutdown

Unlikely causes:

Bottom case, display assembly, duckhead, eDP flex cable, fans, keyboard flex cable, I/O boards, audio board, power adapter, USB-C charging cable, vent/antenna module.

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">Shuts down during startupShuts down unexpectedly during use <p>Note: Inform the user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw.</p> <p>Note: Verify the issue after using the computer for a few minutes to warm it, or by following steps in HT207571: Warm a Mac for testing. Doing this may help identify intermittent issues.</p> <ol style="list-style-type: none">Collect the following details from the user regarding shutdown occurrence and system configuration: when shutdown occurs (for example, on battery power or after running for a while), the frequency of shutdowns, which applications are running at the time, and shutdown repeatability.Verify the battery charge and battery connection status.Unplug the power adapter from the computer, then plug the power adapter back into the computer.Check the USB-C connectors on the power adapter, computer, and charge cable for damage or debris.Hold down the Shift key during startup to put the computer into safe mode. Refer to HT201262: Use safe mode to isolate issues with your Mac.Start up the computer to macOS Recovery. See HT201314: About macOS Recovery.Run Mac Resource Inspector (MRI) to check sensor detection and values.Reset the NVRAM using the procedure for this computer in article HT204063: How to Reset NVRAM or PRAM on your Mac.Reset the SMC using the procedure listed for this computer in article HT201295: How to reset the System Management Controller (SMC) on your Mac.

Deep Dive

	Check	Result	Action	Code	Commodity
1.	Power and thermal issues can cause intermittent shutdowns. Run MRI via AST 2 to check for problems detected by sensors.	Yes	Go to step 2.	\$(nodeText.yesSymptomCode)	
		No	Go to step 7.	\$(nodeText.noSymptomCode)	
	Does MRI report any sensor errors?				

	Check	Result	Action	Code	Commodity
2.	Identify specific type of failure reported in MRI: Thermal/fan sensor or voltage/current sensor.	Voltage/Current Sensor	Go to step 3.	`\${nodeText.yesSymptomCode}`	
	<p>There are three types of sensors that are used in the computer: voltage, current, and temperature. The sensor type is identified by the first letter in the sensor key.</p> <ul style="list-style-type: none"> • Voltage sensor keys start with “V” • Current sensor keys start with “I” • Temperature sensor keys start with “T” <p>Which sensor failure does MRI report?</p>	Thermal/Fan Sensor	Go to the “Computer Runs Hot” troubleshooting flow.	`\${nodeText.noSymptomCode}`	
3.	<p>Verify whether any of the following sensors failed testing in diagnostics:</p> <ul style="list-style-type: none"> • IC0R - CPU Computing High Side current • ICAM - CPU IA core current • ICGM - CPU Vcc GT / GTX current • ICSC - CPU SA current • ID0R - USB-C DC In rail current • IHCC - Flash storage NAND current • VCAC - CPU IA core voltage • VCGC - CPU Vcc GT/GTX voltage • VD0R - USB-C DC In voltage • VP0R - PBus rail voltage <p>Did diagnostics report errors in any of the sensors listed above?</p>	Yes	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M23	MLB
		No	Go to step 4.	`\${nodeText.noSymptomCode}`	
4.	<p>Verify whether any of the following sensors failed testing in diagnostics:</p> <ul style="list-style-type: none"> • IPBR - PBus on battery current <p>Did diagnostics report errors in any of the sensors listed above?</p>	Yes	Go to step 5.	`\${nodeText.yesSymptomCode}`	
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	

	Check	Result	Action	Code	Commodity
5.	<p>Troubleshooting this issue completely requires a known-good top case assembly.</p> <p>Do you have immediate access to a known-good top case assembly?</p>	Yes	Go to step 6.	\${nodeText.yesSymptomCode}	
		No	<p>Replace the top case assembly with keyboard and trackpad.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K43	KEYBOARD

	Check	Result	Action	Code	Commodity
6.	Substitute a known-good top case assembly.	Yes	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M23	MLB
	<p>Run MRI again via AST 2.</p> <p>Does MRI still indicate the same sensor error?</p>		<p>Replace the top case assembly with keyboard and trackpad.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>		

	Check	Result	Action	Code	Commodity
7.	Run MRI and Power Adapter diagnostics.	Yes	Go to step 8.	`\${nodeText.yesSymptomCode}`	
	MRI may report a consumed or defective battery. Power Adapter diagnostics may report a faulty power adapter.	No	Go to step 9.	`\${nodeText.noSymptomCode}`	
	Either issue can cause intermittent shutdowns.				
	Does MRI or Power Adapter diagnostics report a battery or power adapter failure?				
8.	Specify whether MRI or Power Adapter diagnostics reported a battery error or a power adapter error.	Battery	Go to “Battery Not Recognized or Does Not Charge” troubleshooting flow.	`\${nodeText.yesSymptomCode}`	
	Which component failure is reported?	Power Adapter	Go to “Does Not Run on Power Adapter” troubleshooting flow.	`\${nodeText.noSymptomCode}`	
9.	Run CSD and check whether the computer unexpectedly shuts down.	Yes	Go to step 12.	`\${nodeText.yesSymptomCode}`	
	Is the shutdown event reproducible?	No	Go to step 10.	`\${nodeText.noSymptomCode}`	
10.	Check the results for Cooling System Diagnostic via AST 2 to see if any failures were recorded.	Yes	Go to the “Computer Runs Hot” troubleshooting flow.	`\${nodeText.yesSymptomCode}`	
	Are any failures reported by CSD?	No	Go to step 11.	`\${nodeText.noSymptomCode}`	
11.	Run Full System Diagnostic (both EFI and OS) and check whether the computer unexpectedly shuts down.	Yes	Go to step 12.	`\${nodeText.yesSymptomCode}`	
	Is the shutdown event reproducible?	No	No failure was found during testing. Using correct positioning, return the computer to the user with no trouble found.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
12.	<p>Troubleshooting this issue completely requires a known-good logic board.</p> <p>Do you have immediate access to a known-good logic board?</p>	Yes	Go to step 13.	`\${nodeText.yesSymptomCode}`	
		No	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M08	MLB
13.	<p>Substitute a known-good logic board and retest. Try to replicate the shutdown issue.</p> <p>Does the intermittent shutdown issue persist?</p>	Yes	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	
		No	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M08	MLB

	Check	Result	Action	Code	Commodity
14.	Run Full System Diagnostic (both EFI and OS) to verify that the computer does not unexpectedly shut down. Is issue resolved?	Yes	The issue is resolved.	\${nodeText.yesSymptomCode}	
		No	ESCALATION REQUIRED. Contact CSS for additional support or a multipart repair.	X99	

Kernel Panic or System Instability

Unlikely causes:

Bottom case, display assembly, AC wall adapter, fans, keyboard flex cable, I/O boards, audio board, power adapter, USB-C charging cable, vent/antenna module.

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">Computer restarts and displays a kernel panic alert message. Refer to HT200553: If your Mac spontaneously restarts or displays a message that it restarted or shut down because of a problem.Computer freezes during use.Computer freezes upon wake from sleep.Computer freezes when Wi-Fi is turned on or activated. <p>Note: Inform the user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw.</p> <p>Note: Verify the issue after using the computer for a few minutes to warm it, or by following steps in HT207571: Warm a Mac for testing. Doing this may help identify intermittent issues.</p> <ol style="list-style-type: none">Disconnect any external peripherals.Hold the Shift key down during startup to put the computer into safe mode. Refer to HT201262: Use safe mode to isolate issues with your Mac.Follow troubleshooting in HT200553: If your Mac spontaneously restarts or displays a message that it restarted or shut down because of a problem.Use macOS Recovery to troubleshoot potential software issues. Hold down Command-R during startup to restart from the recovery partition. See HT201314: About macOS Recovery.Refer to HT201260: How to find the macOS version number on your Mac to check that the system build is correct for this computer model. Check for and apply the latest software and firmware updates.If the issue cannot be easily reproduced, run the Full System Diagnostic via AST 2 for extended testing.

Deep Dive

	Check	Result	Action	Code	Commodity
1.	Bad memory or a voltage, current, or thermal sensor error can cause kernel panics or system crashes. Run MRI or consult MRI logs to check for any sensor or memory errors.	Yes	Go to step 2.	`\${nodeText.yesSymptomCode}`	
		No	Go to step 8.	`\${nodeText.noSymptomCode}`	
	Does MRI report any sensor or memory errors?				

	Check	Result	Action	Code	Commodity
2.	<p>Identify the specific type of error reported in MRI: a sensor error or a memory (RAM) error.</p> <p>Which error does MRI report: sensor or memory?</p>	Sensor	Go to step 3.	`\${nodeText.yesSymptomCode}`	
		Memory	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M06	MLB
3.	<p>Identify whether MRI reports thermal/fan sensor failure or voltage/current sensor failure.</p> <p>There are three types of sensors that are used in the computer: voltage, current, and temperature. The sensor type is identified by the first letter in the sensor key.</p> <ul style="list-style-type: none"> Voltage sensor keys start with “V” Current sensor keys start with “I” Temperature sensor keys start with “T” <p>Which sensor failure does MRI report?</p>	Voltage/Current Sensor	Go to step 4.	`\${nodeText.yesSymptomCode}`	
		Thermal/Fan Sensor	Go to the “Computer Runs Hot” troubleshooting flow.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
4.	<p>Verify whether any of the following sensors failed testing in diagnostics:</p> <ul style="list-style-type: none"> • IC0R - CPU Computing High Side current • ICAM - CPU IA core current • ICGM - CPU Vcc GT / GTX current • ICSC - CPU SA current. • ID0R - USB-C DC In rail current • IHCC - Flash storage NAND current • VCAC - CPU IA core voltage • VCGC - CPU Vcc GT / GTX voltage • VD0R - USB-C DC In voltage • VP0R - PBus rail voltage <p>Did diagnostics report errors in any of the sensors listed above?</p>	Yes	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M23	MLB
		No	Go to step 5.	\${nodeText.noSymptomCode}	
5.	<p>Verify whether any of the following sensors failed testing in diagnostics:</p> <ul style="list-style-type: none"> • IPBR - PBus on battery current. <p>Did diagnostics report errors in any of the sensors listed above?</p>	Yes	Go to step 6.	\${nodeText.yesSymptomCode}	
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	

	Check	Result	Action	Code	Commodity
6.	<p>Troubleshooting this issue completely requires a known-good top case assembly.</p> <p>Do you have immediate access to a known-good top case assembly?</p>	Yes	Go to step 7.	\${nodeText.yesSymptomCode}	
		No	<p>Replace the top case assembly with keyboard and trackpad.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K42	KEYBOARD

	Check	Result	Action	Code	Commodity
7.	Substitute a known-good top case assembly.	Yes	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M06	MLB
	<p>Run MRI again via AST 2.</p> <p>Does MRI still indicate the same sensor error?</p>		<p>Replace the top case assembly with keyboard and trackpad.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>		

	Check	Result	Action	Code	Commodity
8.	Reset the SMC using the procedure for this computer in HT201295: How to reset the System Management Controller (SMC) on your Mac .	Yes	Issue resolved by resetting SMC and NVRAM. Verify resolution.	`\${nodeText.yesSymptomCode}`	
	Reset the NVRAM using the procedure for this computer in HT204063: How to reset NVRAM or PRAM on your Mac . Does the computer start up and run without a kernel panic or freeze?	No	Go to step 9.	`\${nodeText.noSymptomCode}`	
9.	Use one of the following two methods to start up the computer to a known-good macOS. Start up the computer to macOS Recovery. See HT201314: About macOS Recovery . Follow steps in HT208198: About Startup Security Utility to enable starting up from an external storage device on the user's computer. Then start up the computer to a known-good external macOS startup volume. Attempt to reproduce the issue. Does the computer start up and run without a kernel panic or freeze?	Yes	Go to step 11.	`\${nodeText.yesSymptomCode}`	
		No	Go to step 10.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
10.	Memory is built onto the logic board, therefore it is not exchangeable for testing with known-good memory. Use the memory diagnostic via AST 2 to run extended memory tests. Does the memory fail testing?	Yes	Replace the logic board and Touch ID board. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair. Verify that the issue is resolved.	M06	MLB
		No	Go to step 15.	\$(nodeText.noSymptomCode)	
11.	Run MRI and Storage Diagnostic via AST 2 to verify the functionality of the built-in flash storage. Check only for hardware errors reported by diagnostics, not software or file system errors. Are any hardware issues detected in the flash storage?	Yes	Replace the logic board and Touch ID board. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair. Verify that the issue is resolved.	M06	MLB
		No	Go to step 12.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
12.	<p>Use the results from AST 2 diagnostics to determine the macOS build version that is installed on the computer.</p> <p>Refer to HT201260: How to find the macOS version number on your Mac to check that the system build is correct for this computer model.</p> <p>Is the correct version of macOS installed on the user's drive?</p>	Yes	Go to step 13.	`\${nodeText.yesSymptomCode}`	
		No	<p>Reinstall macOS on the user's computer.</p> <p>Check for and apply the latest software and firmware updates.</p> <p>Verify that the issue is resolved.</p>	`\${nodeText.noSymptomCode}`	
13.	<p>Use one of the following two methods to start up the computer to a known-good macOS.</p> <p>Start up the computer to macOS Recovery. See HT201314: About macOS Recovery.</p> <p>Follow steps in HT208198: About Startup Security Utility to enable starting up from an external storage device on the user's computer. Then start up the computer to a known-good external macOS startup volume.</p> <p>Use Disk Utility to repair the user's internal flash storage volume.</p> <p>Attempt to start up the user's computer from its internal flash storage.</p> <p>Does a kernel panic or crash still occur?</p>	Yes	Go to step 14.	`\${nodeText.yesSymptomCode}`	
		No	The issue is resolved. Verify resolution.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
14.	<p>Follow all steps in HT204743: Partition a problematic drive two times before recommending service or replacement.</p> <p>This will force a rewrite of the partition table.</p> <p>Reinstall macOS on the user's computer. Refer to HT201260: How to find the macOS version number on your Mac to check that the system build is correct for this computer model. Check for and apply the latest software and firmware updates. Verify that the issue is resolved.</p> <p>Does a kernel panic or crash still occur?</p>	Yes	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M06	MLB
		No	<p>The issue is resolved. Verify resolution.</p>	\$(nodeText.noSymptomCode)	
15.	<p>Shut down the computer and wait 30 seconds.</p> <p>Disconnect the eDP (Embedded DisplayPort) flex cable connector from the logic board.</p> <p>Connect an external display via a USB-C video adapter. Start up the computer and retest.</p> <p>Does the kernel panic or crash still occur?</p>	Yes	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M06	MLB
		No	Go to step 16.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
16.	Using magnification, inspect eDP cable for pinching and inspect cable connectors on cable, TCON assembly, and logic board for damaged or defective pins. Did you find cable or connector damage?	Yes	Go to step 17.	\${nodeText.yesSymptomCode}	
		No	Go to step 18.	\${nodeText.noSymptomCode}	
17.	Determine whether the damage is located on the eDP flex cable, the logic board, the TCON assembly, or multiple parts. Is the damage limited to the eDP flex cable?	Yes	Replace eDP flex cable. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair. Verify that the issue is resolved.	X03	INTERNAL CABLE
		No	ESCALATION REQUIRED. Contact CSS for additional support or a multipart repair.	X99	

	Check	Result	Action	Code	Commodity
18.	<p>Continuing to troubleshoot this issue requires a known-good display assembly.</p> <p>Do you have immediate access to a known-good display assembly?</p>	Yes	Go to step 19.	\${nodeText.yesSymptomCode}	
		No	<p>Replace the display assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	L37	LCD

	Check	Result	Action	Code	Commodity
19.	Substitute a known-good display assembly and retest.	Yes	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M06	MLB
	Does the kernel panic or crash still occur?	No	<p>Replace the display assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	L37	LCD

	Check	Result	Action	Code	Commodity
20.	Run full system diagnostics via AST 2 and verify that the system is stable with extended use, making sure the computer does not encounter a crash or kernel panic. Is the issue resolved?	Yes	The issue is resolved. Verify resolution.	\${nodeText.yesSymptomCode}	
		No	ESCALATION REQUIRED. Contact CSS for additional support or a multipart repair.	X99	

No Auto Boot

Unlikely causes:

Bottom case, display assembly, AC wall adapter, eDP flex cable, fans, keyboard flex cable, I/O boards, logic board, audio board, top case assembly, vent/antenna module.

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">• Computer does not start up when display is opened, as expected.• Computer does not start up from shutdown when power adapter is attached, as expected. <p>Note: Inform the user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw.</p> <ol style="list-style-type: none">1. These features are supported on this Apple notebook computer; however not all Apple notebook computers support these startup features.2. Verify that you are using a functional power outlet.3. Inspect the power adapter, connectors, AC wall adapter, and charging cable for damage such as bent plug pins, frayed or exposed wiring, or burn marks.4. Verify that the user's power adapter and charging cable are the correct models for the user's computer. Refer to HT201700: Find the right power adapter and cable for your Mac notebook. Different power adapters and USB-C charging cables may appear similar but may not provide sufficient power to turn on or charge the computer.5. Test the user's power cord or AC wall adapter with a known-good power adapter.6. Test the user's power adapter with a known-good power cord or AC wall adapter.7. Connect the power adapter to each USB-C connector on the computer and retest each time to isolate a possible faulty USB-C port on the user's computer.8. Verify that the user's computer display can open and close freely and completely with no difficulty. Refer to TP1138: Visual/Mechanical Inspection (VMI) Guide for Mac Displays for guidance regarding possible damage to the user's computer display.9. Refer to HT207104: Start up your MacBook Pro or MacBook by opening it or plugging it in for more information about these features and how they are intended to work with this computer.

Deep Dive

	Check	Result	Action	Code	Commodity
1.	Follow Service Guide steps to reenable Boot on Lid Open feature.	Yes	Go to step 2.	`\${nodeText.yesSymptomCode}`	
	Follow steps in TP1484: Auto Boot to retest that this feature has been reenabled and is functioning properly. Does the computer now start up when the display is opened?	No	Go to the “Will Not Start Up” troubleshooting flow.	`\${nodeText.noSymptomCode}`	
2.	Follow Service Guide steps to reenable Boot from Shutdown on AC Attach feature.	Yes	The issue is resolved.	`\${nodeText.yesSymptomCode}`	
	Follow steps in TP1484: Auto Boot to retest that this feature has been reenabled and is functioning properly. Does the computer now start up when the power adapter is attached?	No	Go to the “Power Adapter Issues” troubleshooting flow.	`\${nodeText.noSymptomCode}`	

No Power

Unlikely causes:

Bottom case, display assembly, eDP flex cable, fans, keyboard flex cable, audio board, vent/antenna module.

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">• Computer does not turn on• No image on display and no Caps Lock light when key is pressed <p>Note: Inform the user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover and disconnected the battery.</p> <ol style="list-style-type: none">1. After logic board replacement, if the computer does not turn on, this could mean that the replacement logic board has not yet been configured for use. For complete instructions to configure a replacement logic board, refer to TP1657: System Configuration for Macs with the Apple T2 Security Chip. Always complete all applicable procedures and diagnostic suites after part replacement, to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.2. Verify that you are using a functional power outlet.3. Verify that the user's power adapter and charging cable are the correct models for the user's computer. Refer to HT201700: Find the right power adapter and cable for your Mac notebook. Different power adapters and USB-C charging cables may appear similar but may not provide sufficient power to turn on or charge the computer.4. Check for damage or debris in the USB-C connectors on the computer and the power adapter.5. Inspect the power adapter, connectors, AC wall adapter, and charging cable for damage such as bent plug pins, frayed or exposed wiring, or burn marks.6. Test with a known-good electrical outlet, power source, power adapter, and charging cable that is the correct type for the user's computer.7. Connect the power adapter to each USB-C connector on the computer and retest each time to isolate a possible faulty USB-C port on the user's computer.8. Disconnect all peripherals.9. Determine whether the computer has power by confirming that any of the following function correctly:<ul style="list-style-type: none">• Trackpad clicks when pressed• Power connection feedback occurs• Caps Lock key light turns on when pressed• Display activity functions• Keyboard backlight turns on with ambient light change or when the sensor is covered up• An external display functions10. Follow suggested steps in HT204267: If your Mac doesn't turn on or start up.11. Check if the computer is in recovery mode. This may happen if a software installation is interrupted. Connect the computer to a host Mac. On the host Mac go to Apple > About this Mac > System Report > USB. If the computer is connected and in recovery mode you should see a message such as "Apple Mobile Device (Recovery)". If the computer is in recovery mode, then the computer's T2 firmware will need to be restored using Apple Configurator. Follow steps in Restore Apple T2 firmware on 2018 MacBook Pro to restore the T2 firmware on the user's computer before performing further troubleshooting. Restart the computer and verify that it completely starts up to macOS. Refer to HT208862: About the Apple T2 Security Chip for more

	<p>information.</p> <p>12. Reset the SMC using the procedure listed for this computer in HT201295: How to reset the System Management Controller (SMC) on your Mac. Do not hold in the power button when turning on the computer. You could inadvertently put the computer into DFU mode if you do.</p> <p>13. Refer to the following articles to learn more information about power-related features and functions specific to this computer that may be misinterpreted as service issues:</p> <ul style="list-style-type: none"> • HT207097: Charge your MacBook Pro with Thunderbolt 3 • HT201150: How to turn your Mac on or off • HT204652: If your USB-C power adapter isn't charging your Mac notebook • HT204700: Battery may not charge or drains while using AC power
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Deep Dive

	Check	Result	Action	Code	Commodity
1.	Connect the user's computer to the user's power adapter and charging cable that is connected to a known-good electrical outlet.	Yes	Go to step 2.	`\${nodeText.yesSymptomCode}`	
	<p>The computer should turn on automatically if it is off when the power adapter is connected.</p> <p>Check for any signs of power, such as Caps Lock LED illumination, or keyboard backlight.</p> <p>Does computer show any signs of power activity?</p>	No	Go to step 4.	`\${nodeText.noSymptomCode}`	
2.	Check for a video signal on the built-in display.	Yes	Issue cannot be duplicated.	`\${nodeText.yesSymptomCode}`	
	Is a video image clearly visible on the built-in display?	No	Go to step 3.	`\${nodeText.noSymptomCode}`	
3.	Use a flashlight at a steep angle to the display to check for video output without the backlight.	Yes	Go to the "Backlight Issues or No Backlight" troubleshooting flow.	`\${nodeText.yesSymptomCode}`	
	Is any video visible with the flashlight?	No	Go to the "Power But No Video" troubleshooting flow.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
4.	Inspect the user's power adapter and AC wall adapter for damage.	Yes	Go to the "Mechanical, Physical, or Cosmetic Damage" troubleshooting flow.	\${nodeText.yesSymptomCode}	
	Check the USB-C ports on the user's power adapter and computer for contamination, debris, or damaged pins.				
	Inspect the user's USB-C charging cable and connectors for damage.	No	Go to step 5.	\${nodeText.noSymptomCode}	
	Refer to TP1520: Visual/Mechanical Inspection (VMI) Guide for Mac Portables USB-C Cables when inspecting the user's cable.				
5.	Does the user's power adapter, USB-C charge cable, or duckhead appear damaged?	Yes	Go to step 6.	\${nodeText.yesSymptomCode}	
	Inspect all USB-C ports and top case openings on the user's computer for any signs of deformation, damage, or debris that may be blocking the connection. Use compressed air to clear any obstructions or debris.				
	Important: Do not use any metal objects to clear debris or obstructions, as this can short the connector and cause damage.	No	Go to step 7.	\${nodeText.noSymptomCode}	
	Is any USB-C port damaged?				

	Check	Result	Action	Code	Commodity
6.	<p>Inspect the opening on the top case for the USB-C port. Determine whether the opening is misshapen or deformed, preventing proper insertion of the USB plugs.</p> <p>Is the opening for the USB-C port damaged or deformed?</p>	Yes	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K16	KEYBOARD
		No	<p>Replace the damaged left or right I/O board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M24	OTHER BOARD
7.	<p>Substitute the user's AC wall adapter (duckhead) or power cord for a known-good AC wall adapter or power cord.</p> <p>Attempt normal startup again.</p>	Yes	Replace the power cord or AC wall adapter (duckhead). Verify that the issue is resolved.	X03	EXTERNAL CABLE
		No	Go to step 8.	\${nodeText.noSymptomCode}	
8.	<p>Substitute a known-good, compatible power adapter.</p> <p>Attempt normal startup again.</p>	Yes	Replace the power adapter. Verify that the issue is resolved.	P23	ADAPTER
		No	Go to step 9.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
9.	Substitute a known-good, USB-C charging cable that is the correct type for the user's computer.	Yes	Replace the USB-C charging cable. Verify that the issue is resolved.	X03	EXTERNAL CABLE
	Attempt normal startup again.				
	Does the computer turn on with a known-good charging cable?	No	Go to step 10.	`\${nodeText.noSymptomCode}`	
10.		Yes	Go to step 11.	`\${nodeText.yesSymptomCode}`	
	Unplug the charging cable from the computer.				
	Follow service guide procedures to remove the bottom case and disconnect the battery from the logic board.				
	Connect the charging cable to the computer.	No	Replace the logic board and Touch ID board.		
	Attempt normal startup again.		Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.	M01	MLB
	Does the computer turn on when the battery is disconnected?		Verify that the issue is resolved.		

	Check	Result	Action	Code	Commodity
11.	Substitute a known-good top case with keyboard and trackpad. Attempt normal startup again. Does the computer turn on and attempt startup?	Yes	Replace the top case assembly. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair. Verify that the issue is resolved.	K20	KEYBOARD
		No	Reinstall the user's top case assembly. Replace the logic board and Touch ID board. Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair. Verify that the issue is resolved.	M01	MLB
12.	Verify that the computer can now complete the startup process over multiple trials. Run AST 2 Full System diagnostic suites (EFI & OS), if available, to ensure no other issues remain. Is the issue resolved?	Yes	The issue is resolved.	\${nodeText.yesSymptomCode}	
		No	ESCALATION REQUIRED. Contact CSS for additional support or a multipart repair.	X99	

Power Adapter Issues

Unlikely causes:

Bottom case, display assembly, eDP flex cable, fans, keyboard flex cable, logic board, audio board, vent/antenna module.

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">• No power connection feedback• Battery not charging <p>Note: Inform the user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw.</p> <ol style="list-style-type: none">1. Verify that you are using a functional power outlet.2. Verify that the user's power adapter and charging cable are the correct models for the user's computer. Refer to HT201700: Find the right power adapter and cable for your Mac notebook. Different power adapters and USB-C charging cables may appear similar but may not provide sufficient power to turn on or charge the computer.3. Reset the SMC using the procedure for this computer in HT201295: How to reset the System Management Controller (SMC) on your Mac.4. Check for debris or broken pins on both plugs of the USB-C charging cable. Clean any debris from the plugs accordingly.5. Connect the user's power adapter to a known-good computer and run AST 2 Power Adapter Diagnostic suite to confirm that the power adapter is functioning. <p>Warning: If a power cord or AC wall adapter is damaged, do not connect it to power.</p> <ol style="list-style-type: none">6. If the battery is drained on the user's computer, connect it to a known-good power adapter with a known-good charging cable and charge the computer for up to 10 minutes to verify that the computer's battery can charge. If the user's computer does not charge with a known-good power adapter, return to the list of symptoms and select "Battery Not Recognized or Does Not Charge" from the troubleshooting menu.7. Refer to the following articles to learn more information about power-related features and functions specific to this computer that may be misinterpreted as service issues:<ul style="list-style-type: none">• HT207097: Charge your MacBook Pro with Thunderbolt 3• HT201150: How to turn your Mac on or off• HT204652: If your USB-C power adapter isn't charging your Mac notebook• HT204700: Battery may not charge or drains while using AC power

Deep Dive

	Check	Result	Action	Code	Commodity
1.	Inspect the user's power adapter and AC wall adapter for damage.	Yes	Go to the "Mechanical / Physical / Cosmetic Damage" troubleshooting flow.	\${nodeText.yesSymptomCode}	
	Check the USB-C ports on the user's power adapter and computer for contamination, debris, or damaged pins.				
	Inspect the user's USB-C charging cable and connectors for damage.	No	Go to step 2.	\${nodeText.noSymptomCode}	
	Refer to TP1520: Visual/Mechanical Inspection (VMI) Guide for Mac Portables USB-C Cables when inspecting the user's cable.				
2.	Does the user's power adapter, USB-C charge cable, or duckhead appear damaged?	Yes	Go to step 3.	\${nodeText.yesSymptomCode}	
	Inspect all USB-C ports and top case openings on the user's computer for any signs of deformation, damage, or debris that may be blocking the connection. Use compressed air to clear any obstructions or debris.				
	Important: Do not use any metal objects to clear debris or obstructions, as this can short the connector and cause damage.	No	Go to step 4.	\${nodeText.noSymptomCode}	
	Is any USB-C port damaged?				

	Check	Result	Action	Code	Commodity
3.	<p>Inspect the opening on the top case for the USB-C port. Determine whether the opening is misshapen or deformed, preventing proper insertion of the USB plugs.</p> <p>Is the opening for the USB-C port damaged or deformed?</p>	Yes	<p>Replace the top case assembly.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	K16	KEYBOARD
		No	<p>Replace the damaged left or right I/O board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M24	OTHER BOARD
4.	<p>Connect the user's computer to a known-good power adapter and charging cable that is connected to a known-good electrical outlet.</p> <p>The computer should turn on automatically if it is off when the power adapter is connected.</p> <p>Verify that the computer turns on and charges.</p> <p>Does the computer turn on and charge?</p>	Yes	Go to step 5.	\${nodeText.yesSymptomCode}	
		No	Go to the "No Power" troubleshooting flow.	\${nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
5.	Check System Information > Power > AC Charger Information to verify that the computer recognizes the known-good power adapter.	Yes	Go to step 6.	\${nodeText.yesSymptomCode}	
	Then substitute the user's power adapter and recheck System Information > Power > AC Charger Information to verify that the computer recognizes the user's power adapter.	No	Replace the power adapter. Verify that the issue is resolved.	P23	ADAPTER
	Does the computer recognize the user's power adapter?				
6.	Substitute the user's charging cable with the known-good power adapter.	Yes	Go to step 7.	\${nodeText.yesSymptomCode}	
	Verify that the computer turns on and charges.	No	Replace the USB-C charging cable. Verify that the issue is resolved.	X03	EXTERNAL CABLE
	Does the computer recognize the user's USB-C charging cable?				
7.	Run AST 2 Power Adapter diagnostic suite on the user's computer with the user's power adapter and charging cable connected to confirm that the user's power adapter and charging cable are both functioning.	Yes	Issue cannot be duplicated.	\${nodeText.yesSymptomCode}	
		No	Go to step 8.	\${nodeText.noSymptomCode}	
	Does the computer pass all tests?				
8.	Substitute the user's AC wall adapter (duckhead) or power cord for a known-good AC wall adapter or power cord.	Yes	Replace the power cord or AC wall adapter (duckhead). Verify that the issue is resolved.	X03	EXTERNAL CABLE
	Retest with AST 2 Power Adapter diagnostics.	No	Go to step 9.	\${nodeText.noSymptomCode}	
	Does the computer pass all tests?				
9.	Substitute a known-good, compatible power adapter.	Yes	Replace the power adapter. Verify that the issue is resolved.	P23	ADAPTER
	Retest with AST 2 Power Adapter diagnostics.	No	Replace the USB-C charging cable. Verify that the issue is resolved.	X03	EXTERNAL CABLE
	Does the computer pass all tests?				

	Check	Result	Action	Code	Commodity
10.	<p>Verify that the computer can now charge.</p> <p>Run AST 2 Full System diagnostic suites (EFI & OS), if available, to ensure no other issues remain.</p> <p>Is the issue resolved?</p>	Yes	The issue is resolved.	\${nodeText.yesSymptomCode}	
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	

Will Not Start Up

Unlikely causes:

Bottom case, display assembly, AC wall adapter, eDP flex cable, fans, keyboard flex cable, I/O boards, audio board, power adapter, top case assembly, USB-C charging cable, vent/antenna module.

Quick Check

Symptoms	Quick Check
<ul style="list-style-type: none">• Blank black screen with backlight• Some video activity, Apple logo, progress bar• Prohibitory sign or folder with flashing question mark• Error beep tones• Caps Lock key light toggles on and off when Caps Lock key pressed <p>Note: Inform the user that computer failures due to accidental damage are not covered. If applicable, discuss out-of-warranty repair options. Refer to article OP14: Determining and quoting accidental damage for Mac portables.</p>	<p>Important: Before performing any troubleshooting that requires disassembling the computer, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw.</p> <ol style="list-style-type: none">1. In the event that there is an iBridge/macOS version mismatch in the user's computer, iBridge firmware will update automatically while the computer is connected to the Internet. During this process, the computer's display can remain completely black for at least 30 seconds. If the computer is turned off or disconnected from the Internet during this process under the assumption that something went wrong, the black screen will occur again until the iBridge update has completed. To resolve this issue, plug in the computer, attempt to turn it on, then wait at least one minute to provide an opportunity for any updates to complete if needed. Once completed, the computer should display video once again.2. After logic board replacement, if the computer turns on but displays only a black screen and does not start up, this could mean that the replacement logic board has not yet been configured for use. For complete instructions to configure a replacement logic board, refer to TP1657: System Configuration for MacBook Pro (2018). Always complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.3. Use macOS Recovery to troubleshoot potential software issues. Press and hold Command-R during startup to restart from the recovery partition. See HT201314: About macOS Recovery.4. Refer to HT201260: How to find the macOS version number on your Mac to make sure system build is correct for this computer model. Check for and apply the latest software and firmware updates. Remember that third-party software can contribute to this issue. It may be necessary to check for and apply third-party updates that may not appear in the App Store.5. Verify that startup process passes initial memory checks and POST (Power-On Self-Test) with some video activity. If computer generates beeping sounds, there may be an issue with memory. See HT201702: About Mac Power On Self Test (POST) RAM error codes.6. Try to determine what the computer was doing during startup. Refer to HT204156: About the screens you see when your Mac starts up.7. Follow suggested steps in HT206182: Helping customers with a Mac that doesn't start up.8. Follow suggested steps in HT204463: Fans run at full speed after computer turns on.9. Hold down the Shift key during startup to put the computer into safe mode. Refer to HT201262: Use safe mode to isolate issues with your Mac.10. Reset the SMC using the procedure listed for this computer in HT201295: How to reset the System Management Controller (SMC) on your Mac.11. Reset the NVRAM using the procedure for this computer

	<p>in HT204063: How to Reset NVRAM or PRAM on your Mac.</p> <p>12. Start up from Mac Resource Inspector (MRI), check for the presence of an installed macOS, then refer to HT201260: How to find the macOS version number on your Mac to check that the system build is correct for this computer model.</p> <p>13. If the battery is drained on the user's computer, connect it to a known-good power adapter with a known-good charging cable and charge the computer for up to 10 minutes to verify that the computer's battery can charge. If the user's computer does not charge with a known-good power adapter, return to the list of symptoms and select the “Battery Not Recognized or Does Not Charge” troubleshooting flow.</p> <p>14. Refer to the following articles to learn more information about power-related features and functions specific to this computer that may be mis-interpreted as service issues:</p> <ul style="list-style-type: none"> • HT207097: Charge your MacBook Pro with Thunderbolt 3 • HT207104: Start up your MacBook Pro or MacBook by opening it or plugging it in • HT204652: If your USB-C power adapter isn't charging your Mac notebook • HT204700: Battery may not charge or drains while using AC power
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Deep Dive

	Check	Result	Action	Code	Commodity
1.	Connect the user's computer to the user's power adapter and charging cable that is connected to a known-good electrical outlet.	Yes	Go to step 2.	\$(nodeText.yesSymptomCode)	
	<p>The computer should turn on automatically if it is off when the power adapter is connected.</p> <p>Check for any signs of power by confirming that any of the following function correctly:</p> <ul style="list-style-type: none"> • Trackpad clicks when pressed • Power connection feedback occurs • Caps Lock key light turns on when Caps Lock key pressed • Display activity functions • Keyboard backlight turns on with ambient light change or when the sensor is covered up • An external display functions <p>Does computer show any sign of power activity?</p>	No	Go to the “No Power” troubleshooting flow.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
2.	Disconnect any external peripherals.	Yes	Go to step 4.	\$(nodeText.yesSymptomCode)	
	<p>Reset the NVRAM using the procedure for this computer in HT204063: How to Reset NVRAM or PRAM on your Mac.</p> <p>Check for any signs that the computer is starting up.</p> <p>Can you confirm that the computer is starting up?</p>	No	Go to step 3.	\$(nodeText.noSymptomCode)	
3.	<p>Disconnect the Embedded DisplayPort (eDP) flex cable from the logic board and connect an external display.</p> <p>Attempt to start up the computer normally.</p> <p>Does the computer start up with the built-in display disconnected?</p>	Yes	Go to “Power But Blank/No Video” troubleshooting flow.	\$(nodeText.yesSymptomCode)	
		No	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M02	MLB
4.	Press and hold the Option or Alt key to start up the computer. Observe the startup process to verify that the computer boots to Startup Manager.	Yes	Go to step 5.	\$(nodeText.yesSymptomCode)	
	<p>The startup will show, at a minimum, a black screen with a mouse cursor.</p> <p>Does the computer boot to Startup Manager?</p>	No	Go to “Power But Blank/No Video” troubleshooting flow.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
5.	<p>Start up the computer and determine whether a kernel panic is occurring.</p> <p>Refer to HT200553: If your Mac spontaneously restarts or displays a message that it restarted or shut down because of a problem.</p> <p>Does the computer display a kernel panic during startup?</p>	Yes	Go to the “Kernel Panic / System Instability” troubleshooting flow.	\$(nodeText.yesSymptomCode)	
		No	Go to step 6.	\$(nodeText.noSymptomCode)	
6.	<p>Use one of the following two methods to start up the computer to a known-good macOS.</p> <p>Start up the computer to macOS Recovery. See HT201314: About macOS Recovery.</p> <p>Follow steps in HT208198: About Startup Security Utility to enable starting up from an external storage device on the user’s computer. Then start up the computer to a known-good external macOS startup volume.</p> <p>During startup, allow up to four minutes for a defective flash storage to time out, after which the computer will start up from a known-good external device.</p> <p>Does the computer start up from a known-good volume?</p>	Yes	Go to step 9.	\$(nodeText.yesSymptomCode)	
		No	Go to step 7.	\$(nodeText.noSymptomCode)	
7.	<p>Remove the bottom case and inspect all internal flex cables and connectors for damage.</p> <p>Are any internal cables or connectors damaged?</p>	Yes	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	
		No	Go to step 8.	\$(nodeText.noSymptomCode)	

	Check	Result	Action	Code	Commodity
8.	<p>Reseat the internal connections and reassemble the computer.</p> <p>Attempt a normal startup.</p> <p>Does the computer start up?</p>	Yes	The issue was resolved by reseating the internal connections. Verify resolution.	`\${nodeText.yesSymptomCode}`	
		No	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M02	MLB
9.	<p>Run MRI and Storage Diagnostic via AST 2 to verify the functionality of the built-in flash storage.</p> <p>Check only for hardware errors reported by diagnostics. Do not check for software or file system errors.</p> <p>Are any hardware issues detected in the flash storage?</p>	Yes	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M43	MLB
		No	Go to step 10.	`\${nodeText.noSymptomCode}`	

	Check	Result	Action	Code	Commodity
10.	Use the results from AST 2 diagnostics to determine the macOS build version that is installed on the computer.	Yes	Go to step 11.	\$(nodeText.yesSymptomCode}	
	Refer to HT201260: How to find the macOS version number on your Mac to check that the system build is correct for this computer model. Is the correct version of macOS installed on the user's drive?	No	Reinstall macOS on the user's computer. Check for and apply the latest software and firmware updates. Verify that the issue is resolved.	\$(nodeText.noSymptomCode}	
11.	Use one of the following two methods to start up the computer to a known-good macOS.	Yes	The issue is resolved. Verify resolution.	\$(nodeText.yesSymptomCode}	
	Start up the computer to macOS Recovery. See HT201314: About macOS Recovery . Follow steps in HT208198: About Startup Security Utility to enable starting up from an external storage device on the user's computer. Then start up the computer to a known-good external macOS startup volume. Use Disk Utility to repair the user's internal flash storage volume. Attempt to start up the user's computer from its internal flash storage. Does the computer start up successfully from its internal flash storage?	No	Go to step 12.	\$(nodeText.noSymptomCode}	

	Check	Result	Action	Code	Commodity
12.	<p>Follow all steps in HT204743: Partition a problematic drive two times before recommending service or replacement.</p> <p>This will force a rewrite of the partition table.</p> <p>Reinstall macOS on the user's computer. Refer to HT201260: How to find the macOS version number on your Mac to check that the system build is correct for this computer model. Check for and apply the latest software and firmware updates. Verify that the issue is resolved.</p> <p>Does the computer start up successfully from its internal flash storage?</p>	Yes	The issue is resolved. Verify resolution.	\$(nodeText.yesSymptomCode)	
		No	<p>Replace the logic board and Touch ID board.</p> <p>Refer to the Service Guide to complete all applicable procedures and diagnostic suites after part replacement to ensure that the new part operates properly with the rest of the system. Failure to do so may result in an inoperative system and an incomplete repair.</p> <p>Verify that the issue is resolved.</p>	M44	MLB
13.	<p>Verify that the computer can now complete the startup process over multiple trials.</p> <p>Run any applicable diagnostics to verify that no other issues persist with the computer.</p> <p>Is the issue resolved?</p>	Yes	The issue is resolved.	\$(nodeText.yesSymptomCode)	
		No	<p>ESCALATION REQUIRED.</p> <p>Contact CSS for additional support or a multipart repair.</p>	X99	

About Apple service certifications

Topic

To learn more about accessing [ATLAS](#) and service exams, review these articles:

- [How to get a Tech ID](#)
- [ATLAS frequently asked questions](#)
- [How to access Apple service exams at Pearson VUE](#)
- Certifications Explained Video - ([SV370](#)) for AASPs, ([SV371](#)) for Apple Store employees.

Note: Apple Store employees must read [Understanding Exam and Certification requirements](#) (RS228), in addition to this procedure.

Exams and courses that you need to service iOS products

Training for Apple Certified iOS Technician (ACiT) 2019 is available to technicians who work at Apple-authorized service facilities. Technicians need a Global Service Exchange (GSX) account to see the courses in [ATLAS](#).

To register for any ACiT exam, use [Pearson VUE](#).

ACiT 2019 Certification

With ACiT 2019 certification, you can service iOS devices such as iPhone and iPad, released before March 15, 2019, after passing the following exams:

- Apple Service Fundamentals Exam (SVC-19A)
- ACiT 2019 iOS Service Certification Exam (iOS-19A)

Please note that the following devices have additional requirements:

- iPad Air (3rd generation), iPad mini (5th generation):
 - Also complete the Troubleshooting iPad course ([PQ-054](#)) in ATLAS

ACiT 2018 certification

Important: If you are not already ACiT 2018 certified, complete the ACiT 2019 exam instead.

With ACiT 2018 certification, you can service iOS devices such as iPhone and iPad released before April 2018 after passing the following exams:

- Apple Service Fundamentals Exam (SVC-18A) or (SVC-17A)
- ACiT 2018 iOS Service Certification Exam (iOS-18A)

Please note that the following devices have additional requirements:

- iPad Air (3rd generation), iPad mini (5th generation), iPad Pro 12.9-inch (3rd generation), iPad Pro 11.0-inch
 - Also complete the Troubleshooting iPad course ([PQ-054](#)) in ATLAS.
- iPhone XR:
 - Also complete the iPhone XR Product Qualification ([PQ-046](#)) and iPhone Display Adhesive Product Qualification ([PQ-053](#)) courses in ATLAS.
- iPhone XS and iPhone XS Max:
 - Also complete the iPhone XS and iPhone XS Max Product Qualification ([PQ-045](#)) and iPhone Display Adhesive Product Qualification ([PQ-053](#)) courses in ATLAS.

ACiT 2017 certification

Important: If you are not already ACiT 2017 certified, complete the ACiT 2019 exam instead.

With ACiT 2017 certification, you can service iPhone, iPad, Apple Watch and Apple TV devices released before April 2017 after passing the following exams:

- Apple Service Fundamentals Exam (SVC-17A)
- ACiT 2017 iOS Service Certification Exam (iOS-17A)

Please note that the following devices have additional product qualification requirements:

- iPad Air (3rd generation), iPad mini (5th generation), iPad Pro 12.9-inch (3rd generation), iPad Pro 12.9-inch (2nd Generation), iPad Pro 12.9-inch, iPad Pro 11.0-inch, iPad Pro 10.5-inch, iPad

- Pro 9.7-inch, iPad (6th Generation), iPad (5th Generation) and iPad mini 4
 - Also complete the Troubleshooting iPad course ([PQ-054](#)) in ATLAS.
- iPhone XR
 - Also complete the iPhone XR Product Qualification ([PQ-046](#)) and iPhone Display Adhesive Product Qualification ([PQ-053](#)) courses in ATLAS
- iPhone XS and iPhone XS Max
 - Also complete the iPhone XS and iPhone XS Max Product Qualifications ([PQ-045](#)) and iPhone Display Adhesive Product Qualification ([PQ-053](#)) courses in ATLAS
- iPhone X
 - Also complete the iPhone X Product Qualification course ([PQ-040](#)) in ATLAS
- iPhone 8 and iPhone 8 Plus
 - Also complete the iPhone 8 and 8 Plus Product Qualification course ([PQ-036](#)) in ATLAS.

ACiT 2016 certification

Important: If you are not already ACiT 2016 certified, complete the ACiT 2019 exam instead.

With ACiT 2016 certification, you can service iPhone, iPad, Apple Watch and Apple TV devices released before April 2016 after passing these exams:

- Apple Service Fundamentals Exam (SVC-16A)
- ACiT 2016 iOS Service Certification Exam (iOS-16A)

Please note that the following devices have additional product qualification requirements:

- iPad Air (3rd generation), iPad mini (5th generation), iPad Pro 12.9-inch (3rd generation), iPad Pro 12.9-inch (2nd generation), iPad Pro 12.9-inch, iPad Pro 11.0-inch, iPad Pro 10.5-inch, iPad Pro 9.7-inch, iPad (6th generation), iPad (5th generation), and iPad mini 4
 - Also complete the Troubleshooting iPad course ([PQ-054](#)) in ATLAS.
- iPhone XR:
 - Also complete the iPhone XR Product Qualification ([PQ-046](#)) and iPhone Display Adhesive Product Qualification ([PQ-053](#)) courses in ATLAS
- iPhone XS and iPhone XS Max
 - Also complete the iPhone XS and iPhone XS Max Product Qualification ([PQ-045](#)) and iPhone Display Adhesive Product Qualification ([PQ-053](#)) courses in ATLAS
- iPhone X
 - Also complete the iPhone X Product Qualifications course ([PQ-040](#)) in ATLAS
- iPhone 8 and 8 Plus
 - Also complete the iPhone 8 and 8 Plus Product Qualification course ([PQ-036](#)) in ATLAS
- iPhone 7 and 7 Plus
 - Also complete the iPhone 7 and iPhone 7 Plus Product Qualification course ([9L0-PQ20](#)) in ATLAS.

Exams and courses that you need to service Mac products

Training for Apple Certified Mac Technician (ACMT) 2019 is available to technicians who work at Apple-authorized service facilities. Technicians need a Global Service Exchange (GSX) account to view the courses in [ATLAS](#). To register for any ACMT exam, use [Pearson VUE](#).

ACMT 2019 certification

With ACMT certification, you can service Mac computers released before March 15, 2019 after passing these exams:

- Apple Service Fundamentals Exam (SVC-18A or SVC-19A)
- ACMT 2019 Mac Service Certification Exam (MAC-19A)

Please note that the following devices have additional product qualification requirements:

- MacBook Air (Retina, 13-inch, 2019)
 - Also complete the MacBook Air (Retina, 13-inch, 2019) Product Qualification course ([PQ-062](#)) and Apple T2 Security Chip courses series in ATLAS.
- MacBook Pro (15-inch, 2019)
 - Also complete the MacBook Pro (15-inch, 2019) Product Qualification course ([PQ-044](#)) and Apple T2 Security Chip course series in ATLAS.
- MacBook Pro (13-inch, 2019, Four Thunderbolt 3 ports)
 - Also complete the MacBook Pro (13-inch, 2019, Four Thunderbolt 3 Ports) Product Qualification course ([PQ-043](#)) and Apple T2 Security Chip course series in ATLAS.
- MacBook Pro (13-inch, 2019, Two Thunderbolt 3 Ports)
 - Also complete the MacBook Pro (13-inch, 2019, Two Thunderbolt 3 Ports) ([PQ-063](#)) and

Apple T2 Security Chip courses series in ATLAS.

- iMac (2019)
 - Also complete the iMac 2019 Models Product Qualification course ([PQ-056](#)) in ATLAS.

ACMT 2018 certification

Important: If you're not already ACMT 2018 certified, complete the ACMT 2019 exams instead.

With ACMT 2018 certification, you can service Mac computers released before April 2018 after passing these exams:

- Apple Service Fundamentals Exam (SVC-18A) or (SVC-17A)
- ACMT 2018 Mac Service Certification Exam (MAC-18A)

These computers have additional product qualification requirements:

- MacBook Air (Retina, 13-inch, 2018 and 2019)
 - Also complete the MacBook Air (Retina, 13-inch, 2019) Product Qualification course ([PQ-062](#)) and Apple T2 Security Chip courses series in ATLAS.
- MacBook Pro (15-inch, 2018 and 2019)
 - Also complete the MacBook Pro (15-inch, 2019) Product Qualification course ([PQ-044](#)) and Apple T2 Security Chip course series in ATLAS.
- MacBook Pro (13-inch, 2018 and 2019, Four Thunderbolt 3 ports)
 - Also complete the MacBook Pro (13-inch, 2019, Four Thunderbolt 3 Ports) Product Qualification course ([PQ-043](#)) and Apple T2 Security Chip course series in ATLAS.
- MacBook Pro (13-inch, 2019, Two Thunderbolt 3 Ports)
 - Also complete the MacBook Pro (13-inch, 2019, Two Thunderbolt 3 Ports) ([PQ-063](#)) and Apple T2 Security Chip courses series in ATLAS.
- iMac (2019)
 - Also complete the iMac (2019) Models Product Qualification course ([PQ-056](#)) in ATLAS.
- Mac mini (2018):
 - Also complete the Mac mini (2018) Product qualification course ([PQ-050](#)) and Apple T2 Security Chip course series in ATLAS.

ACMT 2017 certification

Important: If you're not already ACMT 2017 certified, complete the ACMT 2019 exams instead.

With ACMT 2017 certification, you can service most Mac computers released before April 2017 after passing these exams:

- Apple Service Fundamentals Exam (SVC-17A)
- ACMT 2017 Mac Service Certification Exam (MAC-17A)

These computers have additional product qualification requirements:

- MacBook (Retina, 12-inch, 2017):
 - Also complete the MacBook (Retina, 12-inch, 2017) ([9L0-PQ32](#)), Trackpad Calibration Check ([9L0-PQ15](#)) and Interpreting Liquid Contact Indicators (LCIs) ([9L0-PQ30](#)) courses in ATLAS
- MacBook Air (Retina, 13-inch, 2018 and 2019)
 - Also complete the MacBook Air (Retina, 13-inch, 2019) Product Qualification course ([PQ-062](#)) and Apple T2 Security Chip courses series in ATLAS.
- MacBook Air (11-inch, Mid 2013, Early 2014, and Early 2015) and MacBook Air (13-inch, Mid 2013, Early 2014, and 2017):
 - Also complete the MacBook Air course ([9L0-PQ31](#)) in ATLAS.
- MacBook Pro (15-inch, 2018 and 2019)
 - Also complete the MacBook Pro (15-inch, 2019) Product Qualification course ([PQ-044](#)) and Apple T2 Security Chip course series in ATLAS.
- MacBook Pro (15-inch, 2016 and 2017):
 - Also complete the MacBook Pro with Four Thunderbolt 3 Ports ([9L0-PQ24](#)) and the Trackpad Calibration Check ([9L0-PQ15](#)) courses in ATLAS
- MacBook Pro (13-inch, 2018 and 2019, Four Thunderbolt 3 ports):
 - Also complete the MacBook Pro (13-inch, 2019, Four Thunderbolt 3 Ports) Product Qualification course ([PQ-043](#)) and Apple T2 Security Chip course series in ATLAS.
- MacBook Pro (13-inch, 2019, Two Thunderbolt 3 Ports):
 - Also complete the MacBook Pro (13-inch, 2019, Two Thunderbolt 3 Ports) Product Qualification course ([PQ-063](#)) and Apple T2 Security Chip course series in ATLAS.
- MacBook Pro (13-inch, 2016 and 2017, Four Thunderbolt 3 Ports):
 - Also complete the MacBook Pro with Four Thunderbolt 3 Ports ([9L0-PQ24](#)) and the Trackpad Calibration Check ([9L0-PQ15](#)) courses in ATLAS

- MacBook Pro (13-inch, 2016 and 2017, Two Thunderbolt 3 Ports):
 - Also complete the MacBook Pro with Two Thunderbolt 3 Ports ([9L0-PQ23](#)) and the Trackpad Calibration Check ([9L0-PQ15](#)) courses in ATLAS
- iMac (2019):
 - Also complete the iMac (2019) Models Product Qualification course ([PQ-056](#)) in ATLAS.
- iMac Pro (2017):
 - Also complete the Servicing iMac Pro (2017) ([PQ-041](#)) and Apple T2 Security Chip course series in ATLAS.
- iMac (2017):
 - Also complete the iMac (2017) ([9L0-PQ28](#)) course in ATLAS
- Mac mini (2018):
 - Also complete the Mac mini (2018) Product qualification course ([PQ-050](#)) and Apple T2 Security Chip course series in ATLAS.

ACMT 2016 certification

Important: If you're not already ACMT 2016 certified, complete the ACMT 2019 exams instead.

With ACMT 2016 certification, you can service most Mac computers released before April 2016 after passing these exams:

- Apple Service Fundamentals Exam (SVC-16A)
- ACMT 2016 Mac Service Certification Exam (MAC-16A)

These computers have additional requirements:

- MacBook (Retina, 12-inch, Early 2016):
 - Also complete the MacBook (Retina, 12-inch, Early 2016) ([9L0-PQ18](#)) and the Trackpad Calibration Check ([9L0-PQ15](#)) courses in ATLAS.
- MacBook Air (Retina, 13-inch, 2018 and 2019)
 - Also complete the MacBook Air (Retina, 13-inch, 2019) Product Qualification course ([PQ-062](#)) and Apple T2 Security Chip courses series in ATLAS.
- MacBook Air (11-inch, Mid 2013, Early 2014, and Early 2015) and MacBook Air (13-inch, Mid 2013, Early 2014, and 2017):
 - Also complete the MacBook Air course ([9L0-PQ31](#)) in ATLAS.
- MacBook Pro (15-inch, 2018 and 2019):
 - Also complete the MacBook Pro (15-inch, 2019) Product Qualification course ([PQ-044](#)) and Apple T2 Security Chip course series in ATLAS.
- MacBook Pro (15-inch, 2016 and 2017):
 - Also complete the MacBook Pro with Four Thunderbolt 3 Ports ([9L0-PQ24](#)) and the Trackpad Calibration Check ([9L0-PQ15](#)) courses in ATLAS.
- MacBook Pro (13-inch, 2018 and 2019, Four Thunderbolt 3 Ports):
 - Also complete the MacBook Pro (13-inch, 2019, Four Thunderbolt 3 Ports) Product Qualification course ([PQ-043](#)) and Apple T2 Security Chip course series in ATLAS.
- MacBook Pro (13-inch, 2019, Two Thunderbolt 3 Ports):
 - Also complete the MacBook Pro (13-inch, 2019, Two Thunderbolt 3 Ports) Product Qualification course ([PQ-063](#)) and Apple T2 Security Chip course series in ATLAS.
- MacBook Pro (13-inch, 2016 and 2017, Four Thunderbolt 3 Ports):
 - Also complete the MacBook Pro with Four Thunderbolt 3 Ports ([9L0-PQ24](#)) and the Trackpad Calibration Check ([9L0-PQ15](#)) courses in ATLAS
- MacBook Pro (13-inch, 2016 and 2017, Two Thunderbolt 3 Ports):
 - Also complete the MacBook Pro with Two Thunderbolt 3 Ports ([9L0-PQ23](#)) and the Trackpad Calibration Check ([9L0-PQ15](#)) courses in ATLAS
- MacBook (Retina, 12-inch, 2017):
 - Also complete the MacBook (Retina, 12-inch, 2017) ([9L0-PQ32](#)), Trackpad Calibration Check ([9L0-PQ15](#)) and Interpreting Liquid Contact Indicators (LCIs) ([9L0-PQ30](#)) courses in ATLAS
- iMac (2019):
 - Also complete the iMac (2019) Models Product Qualification course ([PQ-056](#)) in ATLAS.
- iMac Pro (2017):
 - Also complete the Servicing iMac Pro (2017) ([PQ-041](#)) and Apple T2 Security Chip course series in ATLAS
- iMac (2017):
 - Also complete the iMac (2017) ([9L0-PQ28](#)) course in ATLAS
- iMac (2015):
 - Also complete the iMac (Late 2015) ([9L0-PQ17](#)) course in ATLAS.
- Mac mini (2018):
 - Also complete the Mac mini (2018) Product qualification course ([PQ-050](#)) and Apple T2 Security Chip course series in ATLAS.

ACMT 2015 certification

Important: If you're not already ACMT 2015 certified, complete the ACMT 2019 exams and courses instead.

With ACMT 2015 certification, you can service many Mac computers (some have additional requirements) if you passed these exams:

- OS X Yosemite Troubleshooting Exam (9L0-066)
- Mac Hardware Service Exam (9L0-012)

These computers have additional requirements:

- MacBook (Retina, 12-inch, 2017):
 - Also complete the MacBook (Retina, 12-inch, 2017) ([9L0-PQ32](#)), Trackpad Calibration Check ([9L0-PQ15](#)) and Interpreting Liquid Contact Indicators (LCIs) ([9L0-PQ30](#)) courses in ATLAS
- MacBook (Retina, 12-inch, Early 2016):
 - Also complete the MacBook (Retina, 12-inch, Early 2016) ([9L0-PQ18](#)) and the Trackpad Calibration Check ([9L0-PQ15](#)) courses in ATLAS.
- MacBook (Retina, 12-inch, Early 2015):
 - Also complete the MacBook (Retina, 12-inch, Early 2015) ([9L0-PQ14](#)) and the Trackpad Calibration Check ([9L0-PQ15](#)) courses in ATLAS.
- MacBook Air (Retina, 13-inch, 2018 and 2019)
 - Also complete the MacBook Air (Retina, 13-inch, 2019) Product Qualification course ([PQ-062](#)) and Apple T2 Security Chip courses series in ATLAS.
- MacBook Air (11-inch, Mid 2013, Early 2014, and Early 2015) and MacBook Air (13-inch, Mid 2013, Early 2014, and 2017):
 - Also complete the MacBook Air course ([9L0-PQ31](#)) in ATLAS.
- MacBook Pro (15-inch, 2018 and 2019)
 - Also complete the MacBook Pro (15-inch, 2019) Product Qualification course ([PQ-044](#)) and Apple T2 Security Chip course series in ATLAS.
- MacBook Pro (15-inch, 2016 and 2017):
 - Also complete the MacBook Pro with Four Thunderbolt 3 Ports ([9L0-PQ24](#)) and the Trackpad Calibration Check ([9L0-PQ15](#)) courses in ATLAS
- MacBook Pro (Retina, 15-inch, Mid 2015):
 - Also complete the MacBook Pro 15-inch (2012 to 2015) ([9L0-PQ34](#)) and the Trackpad Calibration Check ([9L0-PQ15](#)) courses in ATLAS
- MacBook Pro (13-inch, 2018 and 2019, Four Thunderbolt 3 Ports)
 - Also complete the MacBook Pro (13-inch, 2019, Four Thunderbolt 3 Ports) Product Qualification ([PQ-043](#)) and Apple T2 Security Chip course series in ATLAS.
- MacBook Pro (13-inch, 2019, Two Thunderbolt 3 Ports):
 - Also complete the MacBook Pro (13-inch, 2019, Two Thunderbolt 3 Ports) Product Qualification ([PQ-063](#)) and Apple T2 Security Chip course series in ATLAS.
- MacBook Pro (13-inch, 2016 and 2017, Four Thunderbolt 3 Ports):
 - Also complete the MacBook Pro with Four Thunderbolt 3 Ports ([9L0-PQ24](#)) and the Trackpad Calibration Check ([9L0-PQ15](#)) courses in ATLAS
- MacBook Pro (13-inch, 2016 and 2017, Two Thunderbolt 3 Ports):
 - Also complete the MacBook Pro with Two Thunderbolt 3 Ports ([9L0-PQ23](#)) and the Trackpad Calibration Check ([9L0-PQ15](#)) courses in ATLAS
- MacBook Pro (Retina, 13-inch, Early 2015):
 - Also complete the MacBook Pro 13-inch (2012 to 2015) course ([9L0-PQ33](#)) in ATLAS.
- iMac (2019):
 - Also complete the iMac (2019) Models Product Qualification course ([PQ-056](#)) in ATLAS.
- iMac Pro (2017):
 - Also complete the Servicing iMac Pro (2017) ([PQ-041](#)) and Apple T2 Security Chip course series in ATLAS
- iMac (2017):
 - Also complete the iMac (2017) ([9L0-PQ28](#)) course in ATLAS
- iMac (2015):
 - Also complete the iMac (Late 2015) ([9L0-PQ17](#)) course in ATLAS.
- Mac mini (2018):
 - Also complete the Mac mini (2018) Product qualification course ([PQ-050](#)) and Apple T2 Security Chip course series in ATLAS.

ACMT certification

Important: If you're not already ACMT certified, complete the ACMT 2019 exams and courses instead.

With ACMT certification, you can service most Mac computers released before April 2014 after

passing these exams:

- Mac OS X Mavericks Troubleshooting Exam (9L0-065)
- Mac Hardware Service Exam (9L0-011)

These computers have additional requirements. (Some of these exams and courses are not currently available.)

- MacBook (Retina, 12-inch, 2017):
 - Also complete the MacBook (Retina, 12-inch, 2017) ([9L0-PQ32](#)), Trackpad Calibration Check ([9L0-PQ15](#)) and Interpreting Liquid Contact Indicators (LCIs) ([9L0-PQ30](#)) courses in ATLAS
- MacBook (Retina, 12-inch, Early 2016):
 - Also complete the MacBook (Retina, 12-inch, Early 2016) ([9L0-PQ18](#)) and the Trackpad Calibration Check ([9L0-PQ15](#)) courses in ATLAS.
- MacBook (Retina, 12-inch, Early 2015):
 - Also complete the MacBook (Retina, 12-inch, Early 2015) ([9L0-PQ14](#)) and the Trackpad Calibration Check ([9L0-PQ15](#)) courses in ATLAS.
- MacBook Air (Retina, 13-inch, 2018 and 2019)
 - Also complete the MacBook Air (Retina, 13-inch, 2019) Product Qualification course ([PQ-062](#)) and Apple T2 Security Chip courses series in ATLAS.
- MacBook Air (11-inch, Mid 2013, Early 2014, and Early 2015) and MacBook Air (13-inch, Mid 2013, Early 2014, and 2017):
 - Also complete the MacBook Air course ([9L0-PQ31](#)) in ATLAS.
- MacBook Pro (15-inch, 2018 and 2019):
 - Also complete the MacBook Pro (15-inch, 2019) Product Qualification course ([PQ-044](#)) and Apple T2 Security Chip course series in ATLAS.
- MacBook Pro (15-inch, 2016 and 2017):
 - Also complete the MacBook Pro with Four Thunderbolt 3 Ports ([9L0-PQ24](#)) and the Trackpad Calibration Check ([9L0-PQ15](#)) courses in ATLAS.
- MacBook Pro (Retina, Mid 2012) and MacBook Pro (Retina, 15-inch, Early 2013 to Mid 2014):
 - Also complete the MacBook Pro 15-inch (2012 to 2015) ([9L0-PQ34](#)) and the Trackpad Calibration Check ([9L0-PQ15](#)) courses in ATLAS.
- MacBook Pro (13-inch, 2018 and 2019, Four Thunderbolt 3 Ports):
 - Also complete the MacBook Pro (13-inch, 2019, Four Thunderbolt 3 Ports) Product Qualification ([PQ-043](#)) and Apple T2 Security Chip course series in ATLAS.
- MacBook Pro (13-inch, 2019, Two Thunderbolt 3 Ports):
 - Also complete the MacBook Pro (13-inch, 2019, Two Thunderbolt 3 Ports) Product Qualification ([PQ-063](#)) and Apple T2 Security Chip course series in ATLAS.
- MacBook Pro (13-inch, 2016 and 2017):
 - Also complete the MacBook Pro with Four Thunderbolt 3 Ports ([9L0-PQ24](#)) and the Trackpad Calibration Check ([9L0-PQ15](#)) courses in ATLAS.
- MacBook Pro (13-inch, 2016 and 2017, Two Thunderbolt 3 Ports):
 - Also complete the MacBook Pro with Two Thunderbolt 3 Ports ([9L0-PQ23](#)) and the Trackpad Calibration Check ([9L0-PQ15](#)) courses in ATLAS.
- MacBook Pro (Retina, 13-inch, Late 2012 to Early 2015):
 - Also complete the MacBook Pro 13-inch (2012 to 2015) course ([9L0-PQ33](#)) in ATLAS.
- iMac (2019):
 - Also complete the iMac (2019) Models Product Qualification course ([PQ-056](#)) in ATLAS.
- iMac Pro (2017):
 - Also complete the Servicing iMac Pro (2017) ([PQ-041](#)) and Apple T2 Security Chip course series in ATLAS.
- iMac (2017):
 - Also complete the iMac (2017) ([9L0-PQ28](#)) course in ATLAS.
- iMac (2015):
 - Also complete the iMac (Late 2015) ([9L0-PQ17](#)) course in ATLAS.
- iMac (Late 2012 to Mid 2015 models):
 - Also complete the iMac (2012 to 2015) course ([9L0-PQ3](#)) in ATLAS.
- Mac mini (2018):
 - Also complete the Mac mini (2018) Product Qualification course ([PQ-050](#)) and System Configuration for Macs with the Apple T2 Security Chip course ([PQ-048](#)) or Apple T2 Security Chip course series in ATLAS.

About the Apple Service Fundamentals Exam (SVC-19A)

The Apple Service Fundamentals Exam (SVC-19A) is a computer-based knowledge text that Pearson VUE offers online. The test is open resource and test takers should use Apple references and courses in ATLAS to help answer the exam items.

Successful completion of this exam fulfills the prerequisite for Apple Certified iOS Technician (ACiT) 2019 certification and Apple Certified Mac Technician (ACMT) 2019 certification. The SVC-19A exam must be successfully completed before taking the Mac or iOS certification exams.

Exam summary

- Number of sections: 5
- Number of learning objectives: 34
- Number of total items: 70
- Passing score: 80 percent overall (at least 56 out of 70 items to pass)
- Exam time limit: 2 hours

Seven demographic questions are presented at the beginning of the exam. These items aren't scored and don't use the 2 hours given for the exam.

Two separately scored sections must be passed

The exam has two separately-scored sections. Each must be passed to pass the entire exam. This is in addition to the overall passing score listed above. They are:

- ESD Precautions (at least 10 out of the 12 to pass)
- Safety (at least 10 out of 12 to pass)

Sections and topics

Here are the sections and topics covered in Apple Service Fundamentals Exam:

Customer Experience (23 items)

- Identify the probing skills that result in getting good information from the customer
- Select good examples of reflecting and summarizing the customer's answers in order to come to agreement on the issue
- Identify ways to properly position a repair so that the customer knows why it is necessary and is in agreement with the strategy
- Identify ways to position and recommend upgrades and attachments as part of an alternative service strategy.
- Demonstrate use of the "Positive No" in a series of choose-the-phrase exercises
- List practical applications of the four cornerstones of adult learning
- Describe the effect of both complex technical language and over-simplified language
- Identify good examples of phrases to help set accurate customer expectations
- Describe the role of empathy in customer satisfaction
- Identify ways to avoid conflict by using genuine empathy
- Identify causes for conflict in an interaction
- Identify the five-step anger diffusion technique given a customer scenario
- Assess and explain the impact of non-verbal communication

ESD Precautions (12 items)

- Correctly identify and practice ESD precautions
- Correctly identify the components of an ESD-compliant workstation
- Use the proper tools, equipment, and procedures to configure a workspace that minimizes or eliminates the occurrence of electrostatic discharge damage
- Correctly identify the effects of ESD damage on an integrated circuit
- Correctly identify common ESD myths and why they are not true

Safety (12 items)

- Identify those customer statements that will generate a Safety First issue
- Explain the importance of exercising special care when handling lithium-ion/polymer batteries
- Demonstrate the proper and safe handling of batteries
- Recognize and identify signs and symptoms of damaged batteries
- Respond to events involving embedded batteries

Troubleshooting (8 items)

- Identify the different stages of troubleshooting and service where diagnostic tools are useful
- List the components of clear, concise and complete case notes
- Demonstrate basic troubleshooting and deductive reasoning skills
- Use smart questioning techniques and first-level evaluation and isolation skills to identify issues as being generally hardware based, software based, educational, or environmental in nature

Product Knowledge (15 items)

- List and understand basic iOS controls and navigation
- Identify the components of the default macOS user environment
- List Apple Watch controls and Navigation
- Given a customer scenario, evaluate, isolate, and resolve an Apple ID related issue
- List the steps to configure Continuity services in macOS and in iOS
- Describe how to configure a Bluetooth device in an Apple product
- Identify the methods for backing up and restoring data on an Apple product

Courses in ATLAS

To prepare for the Apple Service Fundamentals Exam, we suggest that you review the courses in the Service Fundamentals subject area in ATLAS. The list of courses in the suggested order can be found in [2019 Service Fundamentals](#).

About the ACiT 2019 iOS Service Certification Exam (iOS-19A)

The ACiT 2019 iOS Service Certification Exam is a computer-based knowledge test that Pearson VUE offers online. This is an open-resource test. We encourage you to use Apple references and courses in ATLAS to answer the questions.

To earn Apple Certified iOS Technician (ACiT) 2019 certification, you need to pass this exam (iOS-19A) and the Apple Service Fundamentals Exam (SVC-19A).

Please note: The Apple Service Fundamentals Exam must be taken before you take the iOS Service Certification Exam.

Exam summary

- Number of sections: 2
- Number of learning objectives: 16
- Number of total items: 70
- Passing score: 80 percent overall (at least 56 out of 70 items to pass)
- Exam time limit: 2 hours

Seven demographic questions are presented at the beginning of the exam. These items aren't scored and don't use the 2 hours given for the exam.

Sections and topics

Here are the sections and topics covered in ACiT 2019 Exam:

Troubleshooting (41 items)

- Describe the diagnostics used in troubleshooting a given scenario
- Given an isolated issue, categorize the issue as either hardware (including accidental damage), software, environmental, or educational opportunity
- Identify the steps in the iOS setup and activation process
- List common resolutions for battery-related issues
- Identify basic controls for mailbox management
- Describe the built-in apps and features of iOS
- Describe how to personalize and customize iPhone General and Accessibility settings
- Describe the privacy settings that can be put in place for apps

Servicing iPhone (29 items)

- Identify the physical supplies and online resources necessary to ensure proper and safe servicing of an iPhone model
- Given a simulated workstation, identify the supplies that are necessary to reduce the possibility of being harmed while servicing iPhone
- Identify the tools that are commonly used to service all iOS models
- Identify the correct specialized tools, fixtures, and procedures required to service iPhone 5 and SE models
- Identify the correct specialized tools, fixtures, and procedures required to service iPhone 6 models
- Identify the correct specialized tools, fixtures, and procedures required to service iPhone 7 and iPhone 7 Plus
- Identify the correct specialized tools, fixtures, and procedures required to service iPhone 8 and 8 Plus
- Identify the correct specialized tools, fixtures, and procedures required to service iPhone X models

Courses in ATLAS

To prepare for the ACiT 2019 iOS Service Certification Exam (iOS-19A), we suggest that you review the courses in the ACiT subject area in ATLAS. The list of courses in the suggested order can be found in [ACiT 2019 Overview](#).

About the ACMT 2019 Mac Service Certification Exam (MAC-19A)

The ACMT 2019 Mac Service Certification Exam (MAC-19A) is a computer-based knowledge test that Pearson VUE offers online. This is an open-resource test. We encourage you to use Apple references and courses in ATLAS to answer the questions.

To earn Apple Certified Mac Technician (ACMT) 2019 certification, you need to pass this exam (MAC-19A) and the Apple Service Fundamentals Exam (SVC-19A).

Please note: You must complete the Apple Service Fundamentals Exam before you take the Mac Service Certification Exam.

Exam summary

- Number of sections: 2
- Number of learning objectives: 30
- Number of total items: 70
- Passing score: 80 percent overall (at least 56 out of 70 items to pass)
- Exam time limit: 2 hours

Seven demographic questions are presented at the beginning of the exam. These items aren't scored and don't use the 2 hours given for the exam.

Sections and topics

Here are the sections and topics covered in ACMT 2019 Exam:

Troubleshooting (36 items)

- Evaluate and isolate file system issues with macOS-based systems
- Given a network-related customer issue, accurately evaluate, isolate and resolve the issue
- Correctly identify the diagnostic tool most appropriate to a given troubleshooting scenario
- Describe how to use troubleshooting tools and related procedures
- Identify potential startup issues and associated fixes
- Identify macOS migration tools needed for migration, the types of user data that can be migrated, and the correct methods for migrating user data from both a Mac and PC
- Identify the symptoms that are a result of an SMC that is not functioning correctly
- Explain how to maximize the battery life of an Apple product
- Identify the process to create, configure, manage, and delete user accounts in macOS
- Configure FileVault 2 in macOS to secure the data on a Mac
- Describe the data privacy concerns that are presented when Location Services is enabled in macOS
- Describe the method for resetting a lost Firmware (EFI) password
- Describe how to use Time Machine in macOS to create, restore, and manage a secure data backup

Repairing the Mac Family (34 items)

- Given a simulated workstation, identify the supplies that are necessary to reduce the possibility of damaging the customer's Mac while servicing the computer
- Given a simulated workstation, identify the supplies that are necessary to reduce the possibility of being harmed while servicing Mac models
- Demonstrate the proper and safe handling of batteries and portable computer case assemblies with built-in battery
- Identify specialized tools, fixtures or procedures required to service iMac
- Identify safety precautions necessary to safely service iMac models
- Identify specialized tools, fixtures or procedures required to service iMac Pro
- Identify safety precautions necessary to safely service iMac Pro models
- Identify specialized tools, fixtures or procedures required to service Mac mini
- Identify specialized tools, fixtures or procedures required to service MacBook Pro 13-inch models
- Identify internal connector types for specific MacBook Pro 13-inch models
- Identify specialized tools, fixtures or procedures required to service MacBook Pro 15-inch models

- Identify internal connector types for specific MacBook Pro 15-inch models
- Identify specialized tools, fixtures or procedures required to service MacBook Air
- Identify specialized tools, fixtures or procedures required to service Mac Pro
- Identify internal connector types for specific Mac Pro models
- Identify safety precautions necessary to safely service Mac Pro models
- Identify specialized tools, fixtures or procedures required to service MacBook

Courses in ATLAS

To prepare for the ACMT 2019 Mac Service Certification Exam (MAC-19A), we suggest that you review the courses in the ACMT subject area in ATLAS. The list of courses in the suggested order can be found in [ACMT 2019 Overview](#).

Frequently Asked Questions

Can anyone take the service certification exams?

Yes. Anyone can take the exams to become an Apple Certified Mac Technician (ACMT) 2019 or Apple Certified iOS Technician (ACiT) 2019.

Successfully completing the exams does not mean that Apple has authorized you to perform repairs or to conduct business directly with Apple or on Apple's behalf. Apple certifies (verifies the skills of) technicians. Apple authorizes (establishes business relationships with) service providers. These two things are not the same.

How do I register for the exams?

Go to <https://certifications.apple.com> to register and create a Tech ID. Then use your [Tech ID](#) to register at an Apple Authorized Training Center or online with Pearson VUE. After you have taken an Apple certification exam, you can track and manage all of your Apple certifications at the certifications website.

Where do I go to take the exams?

You can take the exams online from any internet-connected computer.

How do I prepare for the service certification exams?

Apple provides self-paced training courses in ATLAS. Apple Authorized Service Providers (AASPs) and Self-Servicing Accounts (SSAs) can get the Service Training curriculum online for free.

The Apple Service Fundamentals Exam (SVC-19A) has sections on ESD precautions and technician safety. You must pass these sections in order to pass the exam as a whole.

If I don't pass an exam, how soon can I retake it?

You can retake an exam 24 hours after completing the last attempt.

How do I pay for the exams?

When you register for the certification exams, you can pay with Visa, MasterCard, or American Express.

Where can I verify my exams or certification status?

To verify your exam and certification status, go to <https://certifications.apple.com>. In the "Certification" tab, look for the corresponding Certification Name in "My Certifications" and verify that the status is "Certified". To view exam details, click the relevant Certification Name.

I checked my certification status at certifications.apple.com and it is "In Progress". What does that mean?

If your certifications status is "In Progress", it signifies that not all requirements for the certification were completed. To achieve "Certified" status, some certifications require one or more additional courses or exams to be completed. Click on the Certification Name to review the certification details.

What is the Apple T2 Security Chip course series?

In addition to a valid ACMT certification, completion of Apple T2 Security Chip course series is required prior to servicing Mac computers with the Apple T2 Security Chip. Learners complete the course series by completing the Apple T2 Security Chip Training Assessment ([PQ-061](#)) or the System Configuration for Macs with the Apple T2 Security Chip ([PQ-048](#)).

I have certifications on two different TechIDs. What should I do?

Certifications can be migrated from one TechID to another. Send an email to certifications@apple.com with your exam results and TechID information.

I passed my exam, but when I checked my certification it is not on certifications.apple.com. Why is my certification missing?

Your certifications may take up to 72 hours to appear on certifications.apple.com after you pass the exam. If it has been longer, please send an email to certifications@apple.com.

I have other questions. Where can I get them answered?

You can send your questions to svc.trng@apple.com.

Questions about Apple Certified iOS Technician (ACiT) 2019

What is ACiT 2019?

It's a program to become Apple-certified as an iOS technician.

How is ACiT 2019 different from previous ACiT 2018 certification?

ACiT 2019 qualifies a technician to repair iOS products that were produced before March 15, 2019. This includes:

- iPhone XR
- iPhone XS and iPhone XS Max
- iPad Pro 12.9-inch (3rd generation)
- iPad Pro 11-inch

What exams are required for ACiT 2019?

To get ACiT 2019 certification, you need to pass the Apple Service Fundamentals Exam (SVC-19A) or (SVC-18A) and the ACiT 2019 iOS Service Certification Exam (iOS-19A). These exams are available from Pearson VUE.

Does it matter in what order I take the exams?

Yes. Before you can register for the ACiT 2019 iOS Service Certification Exam (iOS-19A), you must pass the Apple Service Fundamentals Exam 2018 or 2019.

How much does each exam cost?

The cost of the exam is \$20 USD (2,215 yen for Japan). Current pricing is available from Apple Authorized Training Centers or [Pearson VUE](https://www.pearsonvue.com).

Where do I find the training for these exams?

Training for these exams is available in [ATLAS](https://atlas.apple.com). Access ACiT 2018 courses at Apple-authorized service facilities.

I'm already ACiT 2018 certified. Do I need to take the new ACiT 2019 exams?

No. If you're certified for the iOS products you need to repair, no new exams are required.

Will separate iOS qualification exams be required for new iOS products?

No. Apple will introduce new qualification courses in ATLAS as products are introduced. You have to complete these courses to service these new products. If new products are introduced after you have been certified, you will need to complete the new courses to service those products.

I've completed the SVC-18A exam. How long will the iOS-18A exam be available? Do I need to take two new exams for ACiT certification?

If you've completed the SVC-18A for ACiT 2018, the ACiT exam will be available until May 14, 2019. Until then, completion of SVC-18A and iOS-18A exams will still grant you ACiT 2018 certification, but it won't cover as many products. To get ACiT 2019 certification, review the updated training materials and successfully complete the iOS-19A exam.

I have completed the Apple Certified Mac Technician (ACMT) 2019 certification. Do I need to take two new exams for ACiT certification?

No. If you are ACMT 2019 certified, you've passed the Apple Service Fundamentals Exam. You only need to pass the ACiT 2019 iOS Service Certification Exam (iOS-19A) to be ACiT 2019 certified.

When I complete the requirements for ACiT 2019, can I request a printed certificate?

Yes. After you pass the required exams, send an email to certifications@apple.com and ask for a certificate. You'll get an email with a link to the request form.

I have other questions. Where can I get them answered?

You can send your questions to svc.trng@apple.com.

Questions about Apple Certified Mac Technician (ACMT) 2019

What is ACMT 2019?

Apple Mac Technician (ACMT) 2019 is a new version of the Apple Certified Mac Technician certification.

How is ACMT 2019 different from previous ACMT certifications?

ACMT 2019 qualifies a technician to repair all the Mac products that were covered by prior ACMT certifications, plus all other Mac products that were produced before March 15, 2019. This includes MacBook and MacBook Pro products that required a separate qualification exam or course in ATLAS:

- MacBook Air (Retina, 13-inch, 2018)
- Mac mini (2018)
- MacBook Pro (15-inch, 2018)
- MacBook Pro (13-inch, 2018, Four Thunderbolt 3 Ports)

ACMT 2019 allows a technician who works at an Apple-authorized service facility to service all of these products.

What exams are required for ACMT 2019?

To get ACMT 2019 certification, you need to pass the Apple Service Fundamentals Exam (SVC-19A) or (SVC-18A) and ACMT 2019 Mac Service Certification Exam (MAC-19A). These exams are available from Pearson VUE.

Does it matter in what order I take the exams?

Yes. Before you can register for the ACMT 2019 Mac Service Certification Exam (MAC-19A), you must pass the Apple Service Fundamentals Exam (SVC-19A or SVC-18A)

How much do each of the exams cost?

The cost of the exam is \$20 USD (2,215 yen for Japan). Current pricing is available from Apple Authorized Training Centers or [Pearson VUE](#).

Where do I find the training for these exams?

Training for these exams is available in [ATLAS](#). You can access ACMT 2018 courses at Apple authorized service facilities.

I'm already ACMT 2018 certified. Do I need to take the new ACMT 2019 exams?

No. If you are certified for the Mac products you need to repair, no new exams are required.

I've completed the Apple Certified iOS Technician (ACiT 2018) certification. Do I need to take two new exams for ACMT certification?

No. If you are ACiT 2019 certified, you've already passed the Apple Service Fundamentals Exam. You only need to take and pass the ACMT 2019 Mac Service Certification Exam (MAC-19A) to be ACMT 2019 certified.

Will separate Mac qualification exams still be available?

Apple will publish new qualification courses in ATLAS for new Apple products as needed. If you're already ACMT certified and want to repair a product with separate qualification requirements, you will be able to complete those specific courses. Credentials will populate GCX and GSX in 48-72 hours.

I've completed one of the previous ACMT 2018 exams. Do I need to take two new exams for ACMT certification?

If you've completed the SVC-18A exam for ACMT, the remaining ACMT exam will be available until May 14, 2019. Until then, completion of SVC-18A and MAC-18A exams will still grant you ACMT 2018 certification, but it won't cover as many products. To get ACMT 2019 certification, review the updated training materials and successfully complete the MAC-19A exam.

What will I have to do to service new Mac products that are introduced after I'm certified?

Apple will introduce new qualification courses in ATLAS as products are introduced. You have to complete these courses to service the new products.

When I complete the requirements for ACMT 2019, can I request a printed certificate?

Yes. After you pass the required exams, send an email to certifications@apple.com and ask for a certificate. You'll get an email with a link to the request form.

I have other questions. Where can I get them answered?

You can send your questions to svc.trng@apple.com.

Repair Requirements based on Graphics Configuration

Repair Requirements based on Graphics Configuration

MacBook Pro (15-inch, 2018) is available with different types of graphics cards. The graphics card will determine the specific logic board, heat sink, and bottom case used in a repair. To ensure you are ordering the correct part, refer to [TP1642: Exploded View](#).

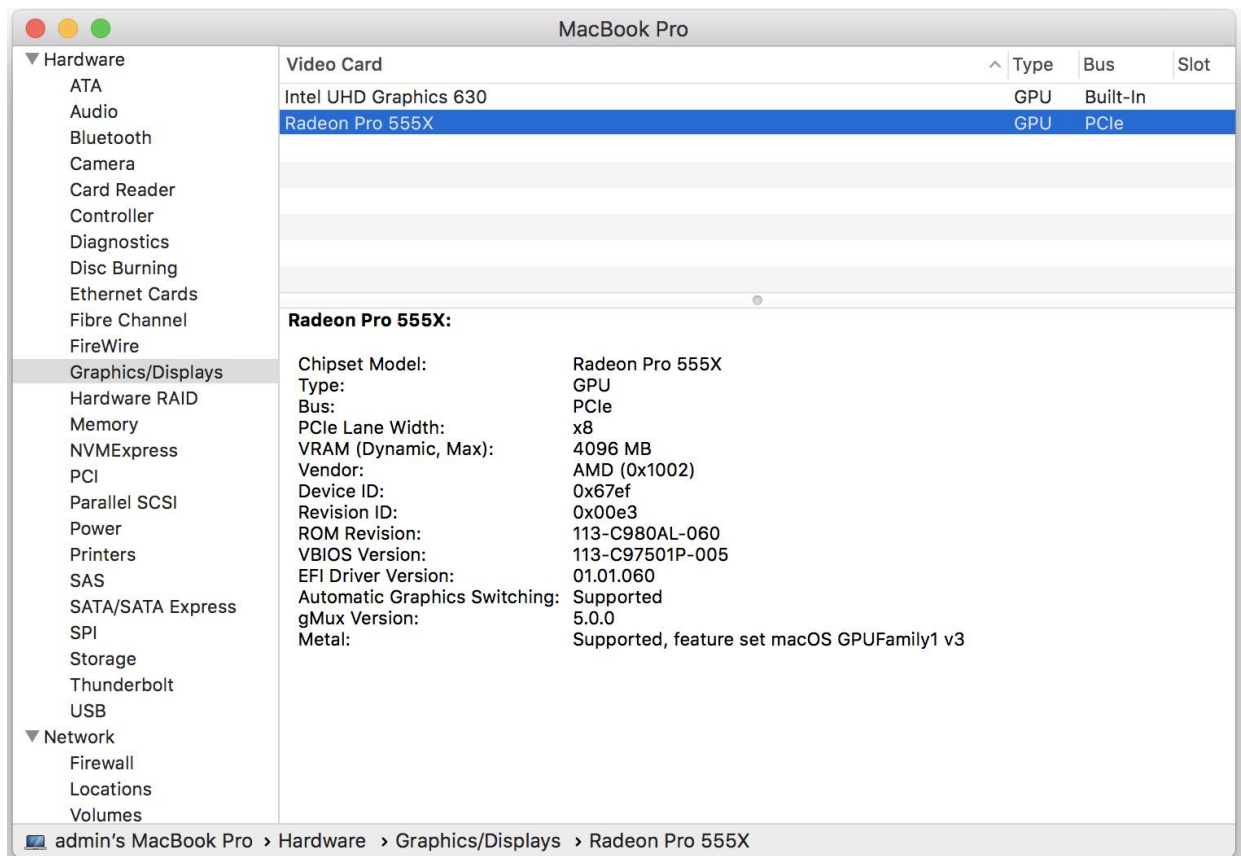
To determine which model you are working with, use one of the steps below.

1. For a MacBook Pro (15-inch, 2018) with power:

- Go to About This Mac and click on System Report.



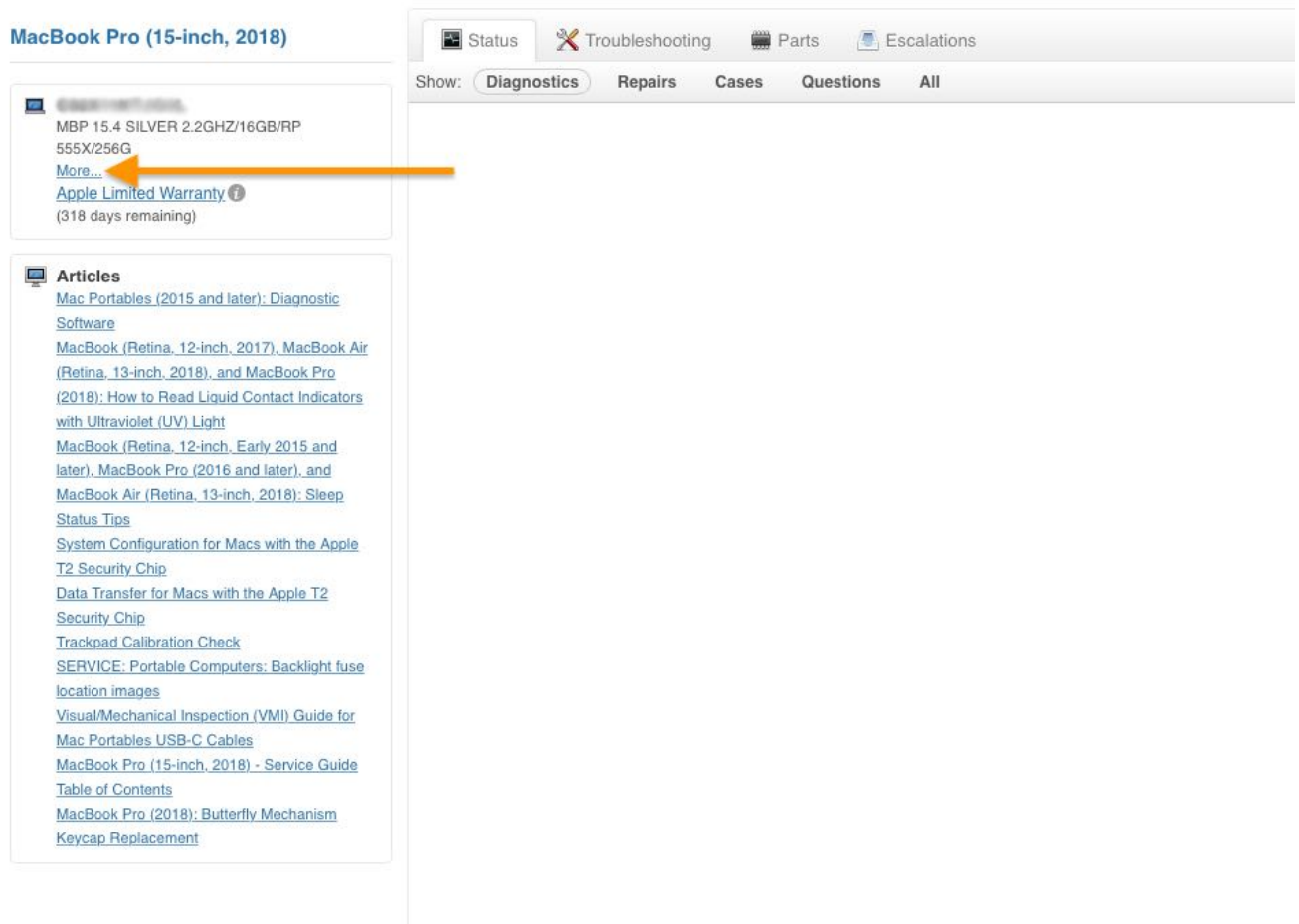
- Navigate to Graphics/Displays and determine which graphics card the computer has. This will determine which model MacBook Pro (15-inch, 2018) you are working with. You will see one of the following:
 - Radeon Pro 555X
 - Radeon Pro 560X
 - Radeon Pro Vega 16
 - Radeon Pro Vega 20



- Refer to [TP1642: Exploded View](#) to make sure the correct part is ordered.

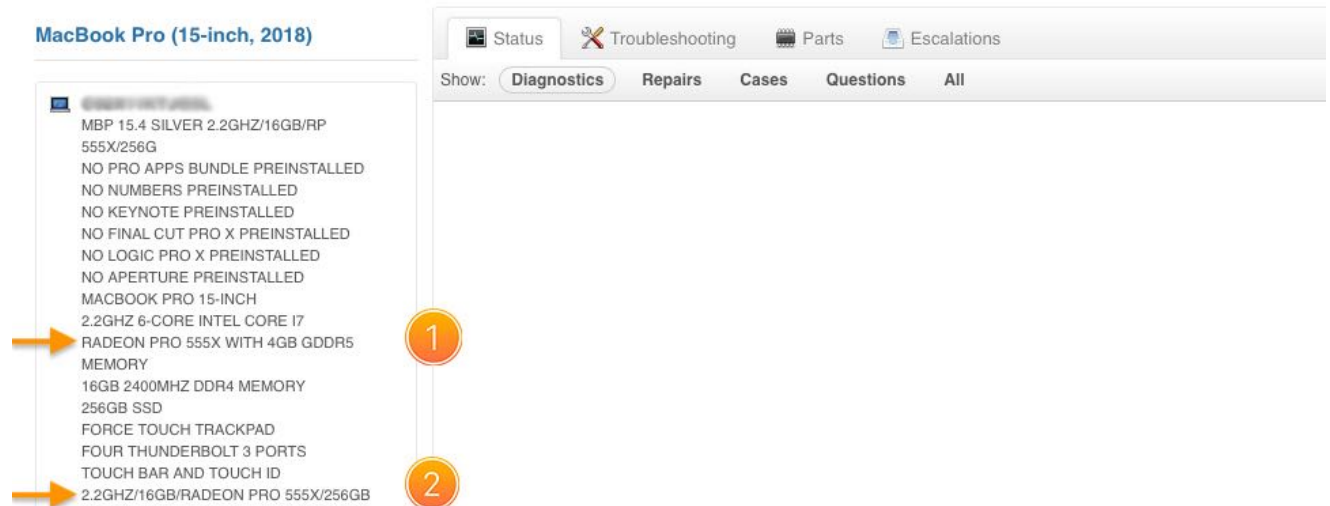
2. For a MacBook Pro (15-inch, 2018) with or without power:

- Enter the computer serial number into GSX. Click “more” to get technical specifications.



- Find the graphics card information (1) in the tech specs list. This will determine which model MacBook Pro (15-inch, 2018) you are working with. You will also see the complete logic board information (2). Graphics card will be one of the following:
 - Radeon Pro 555X
 - Radeon Pro 560X

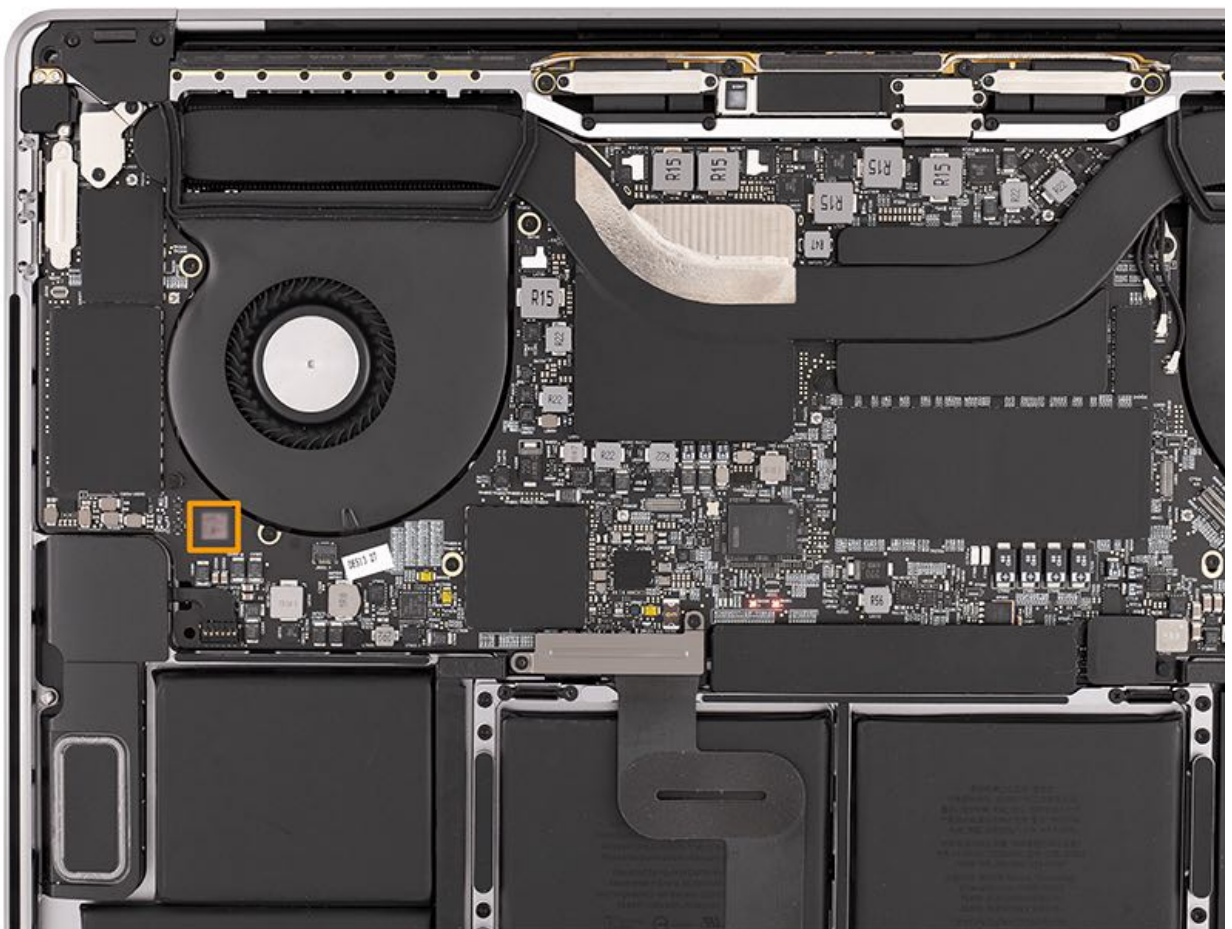
- Radeon Pro Vega 16
- Radeon Pro Vega 20



- Refer to [TP1642: Exploded View](#) to make sure the correct part is ordered.

3. For a MacBook Pro (15-inch, 2018) that does not power on:

- Scan the 2D bar code on the logic board to determine the EEEE code. Refer to [OP67: How to find a part using the EEE/EEEE code](#).



- Refer to [TP1642: Exploded View](#) to make sure the correct part is ordered.

Bottom Case

When replacing a bottom case:

- If the computer you are working on has a Radeon Pro 555X or Radeon Pro 560X graphics card, order:
 - 923-02509, space gray
 - 923-02510, silver

- If the computer you are working on has a Radeon Pro Vega 16 or Radeon Pro Vega 20 graphics card, order:
 - 923-00485, space gray
 - 923-00486, silver

Heat Sink

When replacing a heat sink:

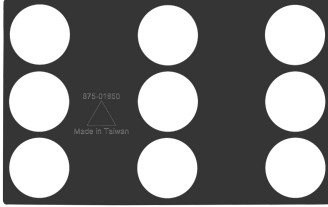
- For Radeon Pro 555X or Radeon Pro 560X graphics card, order:
 - 076-00383
- For Radeon Pro Vega 16 or Radeon Pro Vega 20 graphics card, order:
 - 076-00406

Trackpad Calibration Check

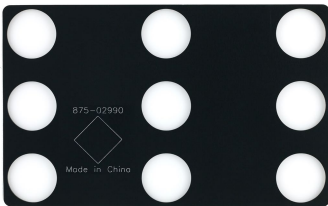
For video instruction, refer to [SV279: Force Touch Trackpad Calibration Check Video](#).

Required tools:

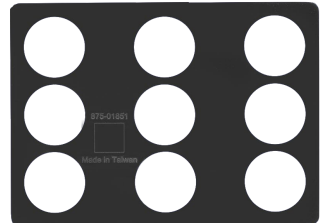
- Weight Placement Rubber Template (923-00555)
 - MacBook (Retina, 12-inch, Early 2015, Early 2016, and 2017)



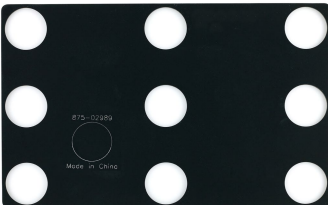
- Weight Placement Rubber Template (923-01316)
 - MacBook Pro (13-inch, 2016, 2017, and 2019, Two Thunderbolt 3 Ports)
 - MacBook Pro (13-inch, 2016, 2017, 2018, 2019, Four Thunderbolt 3 Ports)



- Weight Placement Rubber Template (923-00599)
 - MacBook Pro (Retina, 13-inch, Early 2015) and (Retina, 15-inch, Mid 2015)



- Weight Placement Rubber Template (923-01317)
 - MacBook Pro (15-inch, 2016, 2017, 2018, 2019)



- Weight Placement Rubber Template (923-02462)
 - MacBook Air (Retina, 13-inch, 2018 and 2019)



Note: Weight Placement Rubber Templates come in a pack of three. If the edges start to curl, it is necessary to order a new pack.

- 200g and 800g weights (923-00462)

**Steps:**

To verify that the trackpad is responding as expected, run the Trackpad Calibration Check after every repair, including when only the bottom case has been removed and reassembled.

Note: It is recommended to also run the Trackpad Response test after a top case with keyboard has been replaced, or if the user is having issues related to trackpad functionality.

1. Place the Weight Placement Rubber Template on the trackpad before launching the test in AST 2. This establishes the correct baseline for the weights.

Important: Do not tape the Weight Placement Rubber Template to the top case. Tape may cause inaccurate test results.



2. Launch AST 2. In Diagnostic Console, select Trackpad Calibration Check from the list of diagnostic suites. For more information on AST 2, refer to [TP1279: AST 2: Supported Products and Tests](#).

Caution: The Trackpad Calibration Check is very sensitive to external disturbances. Run the test on a flat surface. Do not

run the diagnostic on a bench where other technicians are working. To avoid interfering with the results, be sure to place weights down gently on a separate surface while running the diagnostic. If the computer is bumped or jostled while the diagnostic is running, restart the test.

Diagnostic Console

John Doe |

< Diagnostic Results

Diagnostic Suites

TRIAGE

Trackpad Response

Assists in verifying functionality of trackpad.

3 minutes

>

REPAIR

Trackpad Calibration Check

Verifies calibration of the trackpad actuator and force sensor.

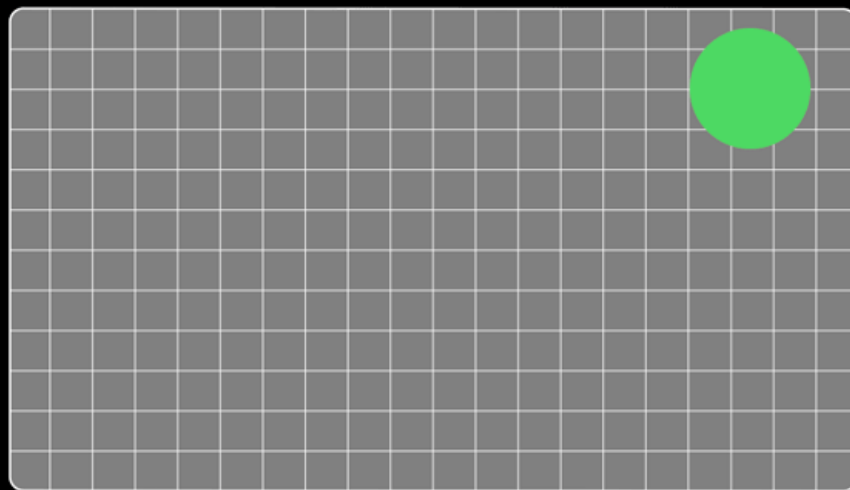
3 minutes

>

3. The diagnostic suite consists of several stages. The first stage of the suite is the Force Check, which is interactive and requires placing the 200g and 800g weights as indicated. The blue dot will indicate where on the trackpad to place each weight. The text at the bottom of the screen will indicate which weight to use at each step. The dot will turn green when it is time to lift the weight from the trackpad.

Test Instruction

Place the 200g weight on the indicated area and press any key.



Test Instruction

Remove the weight from the indicated area and press any key.

4. The next stage is the Actuator Check. During this stage, the trackpad will make clicking sounds while the actuator is tested. If any issues with the actuator are identified, the test may need to proceed to the next stage, which is the Actuator Calibration. The trackpad will continue to make clicking sounds while the actuator is calibrated. During this process, the unit under test (UUT) will display the screen shown below.

Checking your Mac...



Restart



Shut Down

5. If no issues are found, the screen will look like the image below. The trackpad calibration is verified.



About Device



Input Device

- ✓ Actuator Calibration
- ✓ Critical Error Test
- ✓ Open Test
- ✓ Force Check

6. If issues were found in the Actuator Check, the Actuator Calibration, or the Force Check, the screen will look like the image below and the suite should be run again. If the computer fails a second time, a top case with keyboard replacement is recommended.



MacBook Pro
C0282-001-0000-000

Issues Found

Trackpad Calibration Check
October 20th, 2016 2:19 PM



About Device



Input Device

- ✓ Actuator Calibration
- ✓ Critical Error Test
- ✓ Open Test
- ! Force Check

System Configuration for Macs with the Apple T2 Security Chip

System Configuration for Macs with the Apple T2 Security Chip

For Macs with the Apple T2 Security Chip, the repair process is not complete for the replacement of certain parts until the AST 2 System Configuration suite has been run successfully. This step is required for Apple certified technicians to ensure repair quality and compliance with regional communications regulations.

Completion of this process ensures the security features of the Apple T2 Security Chip function properly, enabling on-the-fly hardware encryption, biometric authentication, and secure boot protection.

- The System Configuration suite executes a variety of steps depending on the parts used in the repair. A series of presence tests are conducted to verify components related to the Apple T2 Security Chip have been reconnected correctly. This includes the Touch ID sensor, ambient light sensor, Touch Bar, and camera.
- Then the Touch ID sensor and Touch Bar are paired to the logic board and their calibration values are updated to optimize their performance. For a logic board replacement, the system serial number is written to the new logic board, the logic board serial number is reported to Apple to enable iCloud services including FaceTime, Messages, and Apple Pay, and the wireless region is assigned.

Note: To ensure compliance with regional communications regulations, the system will boot to a flashing prohibitory sign until the wireless region has been assigned.

- The final step for all repair types is to update the Apple T2 Security Chip firmware to the most current version.
- The exact steps executed are visible in the AST 2 Diagnostic Console by selecting the suite in Diagnostics Results and clicking Details.

Important: If logic board or flash storage has been replaced, make sure the customer's current data is backed up before starting this procedure. Neither data nor data recovery will be available once System Configuration has been performed.

This article contains:

- [When System Configuration is Required](#)
- [Tools](#)
- [Before Starting an AST 2 Session](#)
- [Steps](#)
- [Troubleshooting Tips](#)

When System Configuration is Required

Computer Model	Logic Board	Top Case	Display	Touch ID	Flash Storage
iMac Pro (2017)	•				•
Mac mini (2018)	•				
MacBook Air (Retina, 13-inch, 2018)	•			•	
MacBook Air (Retina, 13-inch, 2019)	•		•	•	
MacBook Pro (13-inch, 2019, Two Thunderbolt 3 Ports)	•	•	•	•	
MacBook Pro (13-inch, 2018, Four Thunderbolt 3 Ports)	•	•	•	•	
MacBook Pro (13-inch, 2019, Four Thunderbolt 3 Ports)	•	•	•	•	
MacBook Pro (15-inch, 2018)	•	•	•	•	
MacBook Pro (15-inch, 2019)	•	•	•	•	

Tools

- Power cord
- USB-C to USB-C Charge Cable included with portables (661-06670) or USB-A to USB-C Apple TV Restore Cable (923-00504)

Note: Thunderbolt 3 cables are not supported.



- A host computer with:
 - macOS Mojave 10.14.5 or later.
 - [Mac Configuration Utility \(MCU\)](#) installed. For information on how to set up the host computer, refer to [OP476: Latest Apple Service Toolkit download links and documentation](#).
 - Internet connection.

Before Starting an AST 2 Session

- Be sure parts have been added to the repair.
- Be sure known good board (KGB) and known bad board (KBB) serial numbers have been added to the repair.
Important: If the serial numbers are not entered and saved in the repair system correctly, the System Configuration suite will not become available.
- Be sure the repair has been saved.

Note: The logic board serial number must be entered in upper case characters. To ensure accuracy, it is recommended to scan the QR code on the logic board.

Steps

1. Start a diagnostic session on the AST 2 [Diagnostic Console](#).
2. Connect the customer's computer to the host computer. If the host computer does not have a USB-C port, use a USB-C to USB-A cable. It is important to connect the USB-C cable to the correct port on the customer's computer or the process will not run.

Important: Be sure both the customer's computer and the host computer are connected to power.

Notebooks: Use only the USB-C port closest to the caps lock key.



For iMac Pro: Use only the USB-C port closest to the Ethernet port.



For Mac mini (2018): Use only the USB-C port closest to the HDMI port.



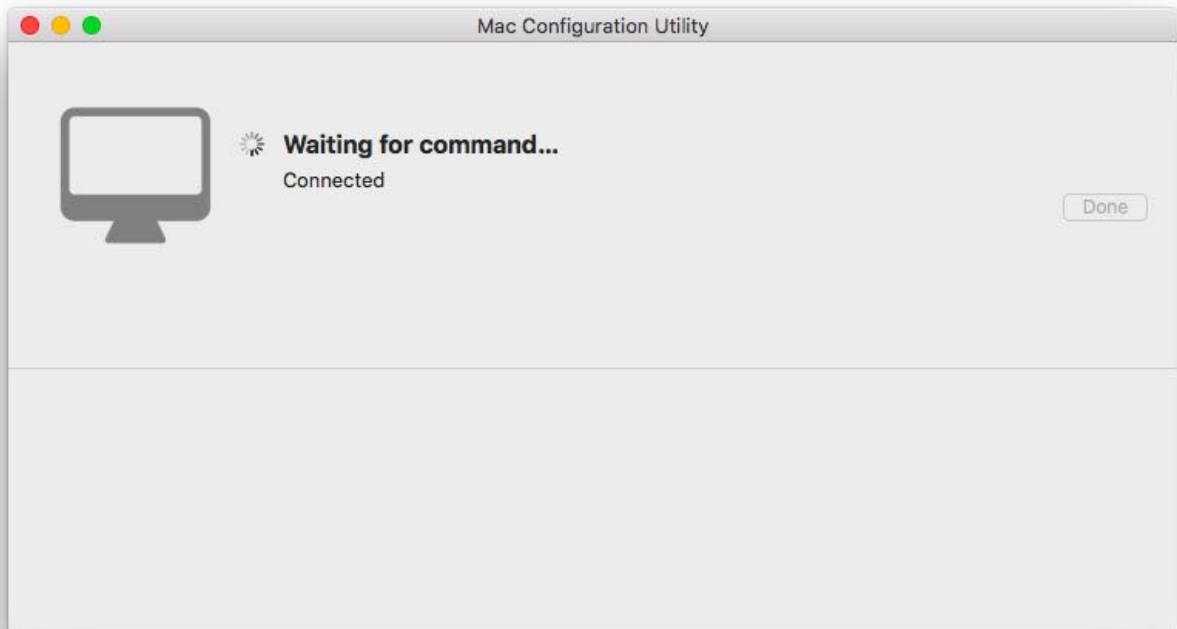
3. Verify that the host computer is turned on, connected to power, and connected to the Internet.

4. Start up the customer's computer in Device Firmware Update (DFU) mode. For more information on DFU mode, refer to

[TP1758: Device Firmware Update \(DFU\) mode for Computers with the Apple T2 Security Chip.](#)

- **For desktops:** Press and hold the power button on the rear enclosure while connecting the power cord. Continue to hold the power button until you see the prompt appear in Mac Configuration Utility, which may take up to 10 seconds. For video instruction, refer to [SV402: Desktop Computers with the Apple T2 Security Chip: DFU Mode](#).
- **For notebooks:** Press and hold the power button, then press and hold Left Control-Left Option-Right Shift until you see the prompt appear in Mac Configuration Utility, which may take up to 10 seconds. For video instruction, refer to [SV401: Notebook Computers with the Apple T2 Security Chip: DFU Mode](#).

5. If DFU has been performed correctly, MCU will automatically launch and a dialog box will appear on the host computer screen.



Note: If a diagnostic session has not been created yet, this message will appear:

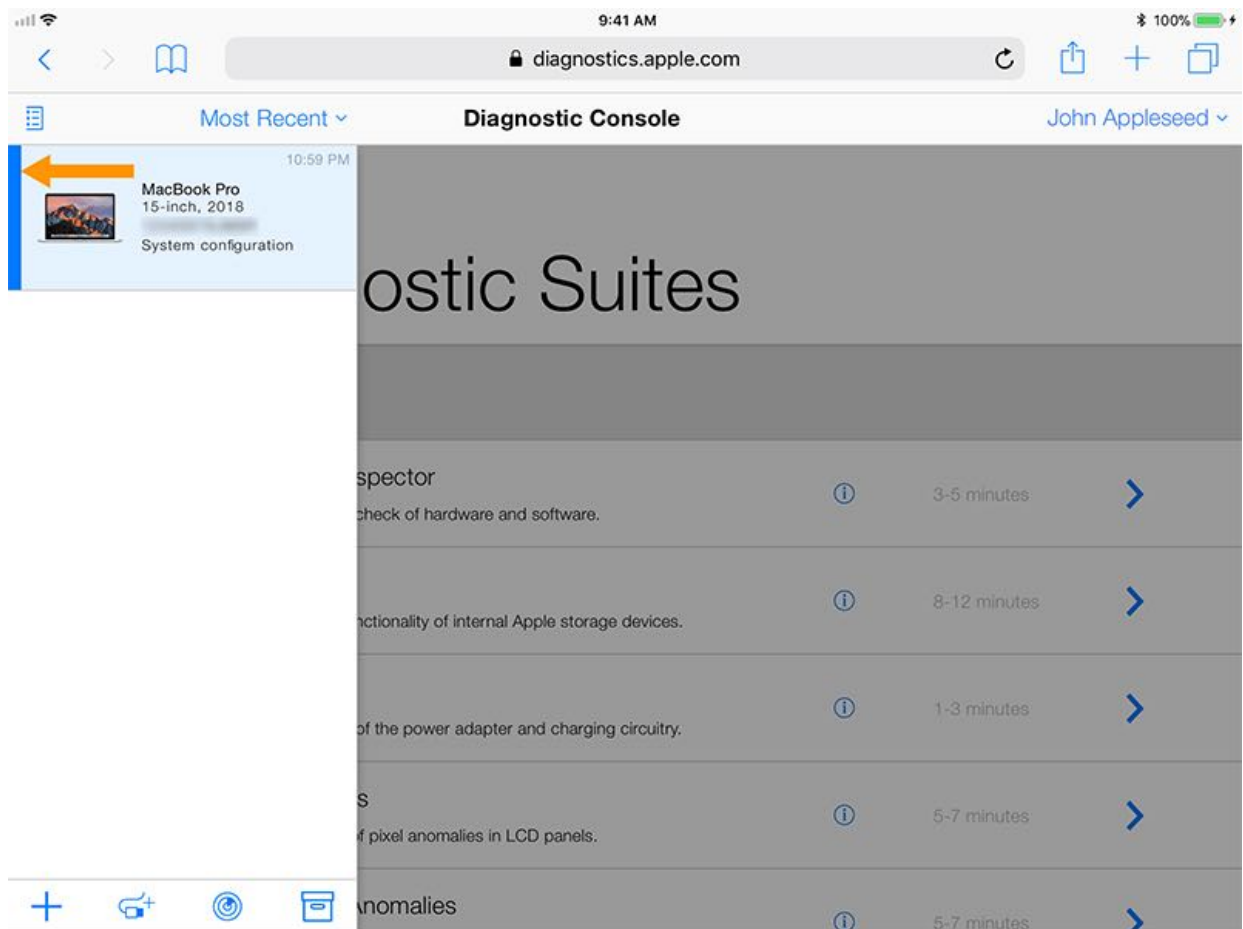


6. Confirm that the customer's computer appears online in the Diagnostic Console. You will see a blue bar next to the name

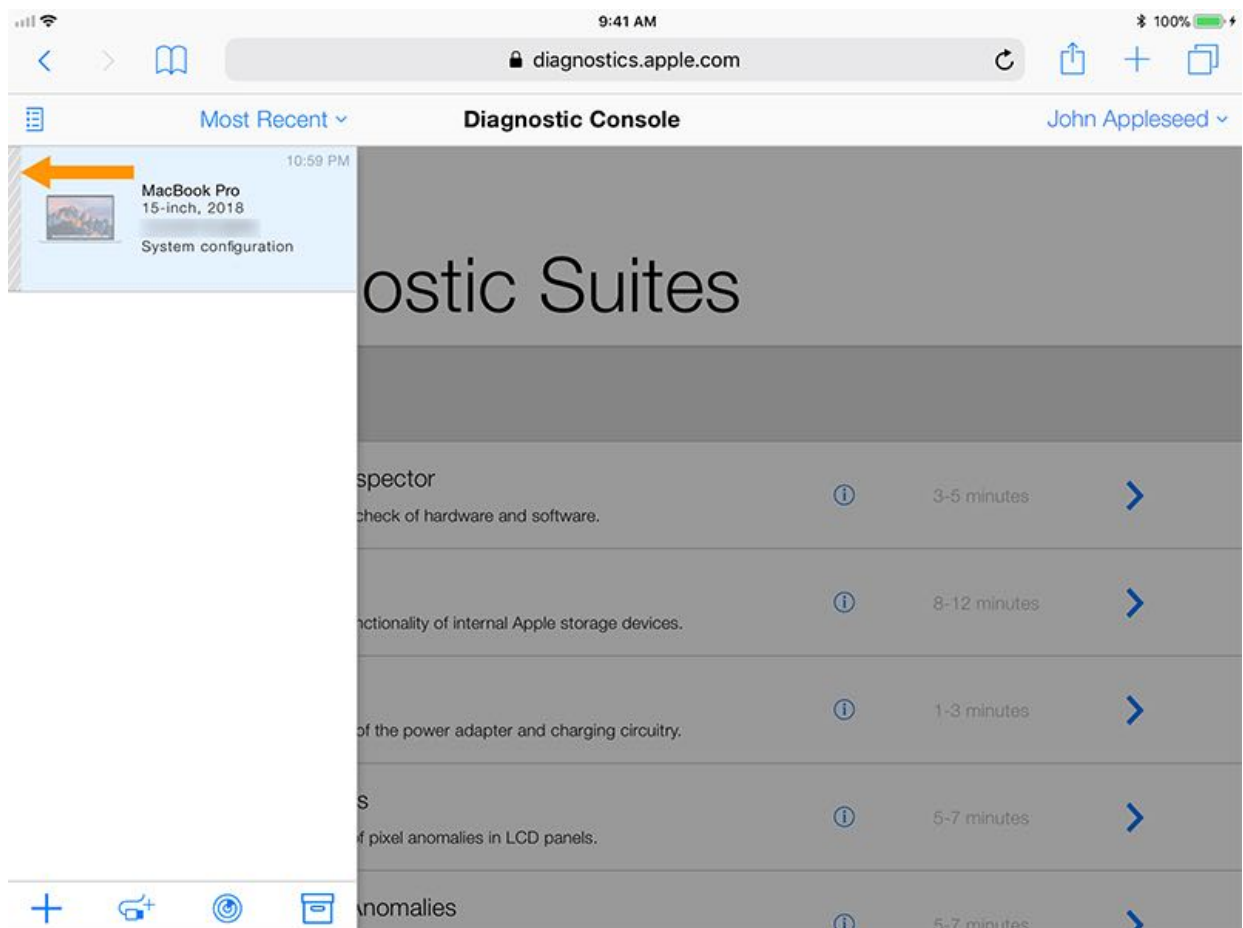
and serial of the customer's computer.

Note: If the computer does not appear, the serial number may have been entered incorrectly or the repair was not saved correctly. Both the system serial number and the part serial numbers must be accurate to continue.

- **Connected**



- **Not Connected**



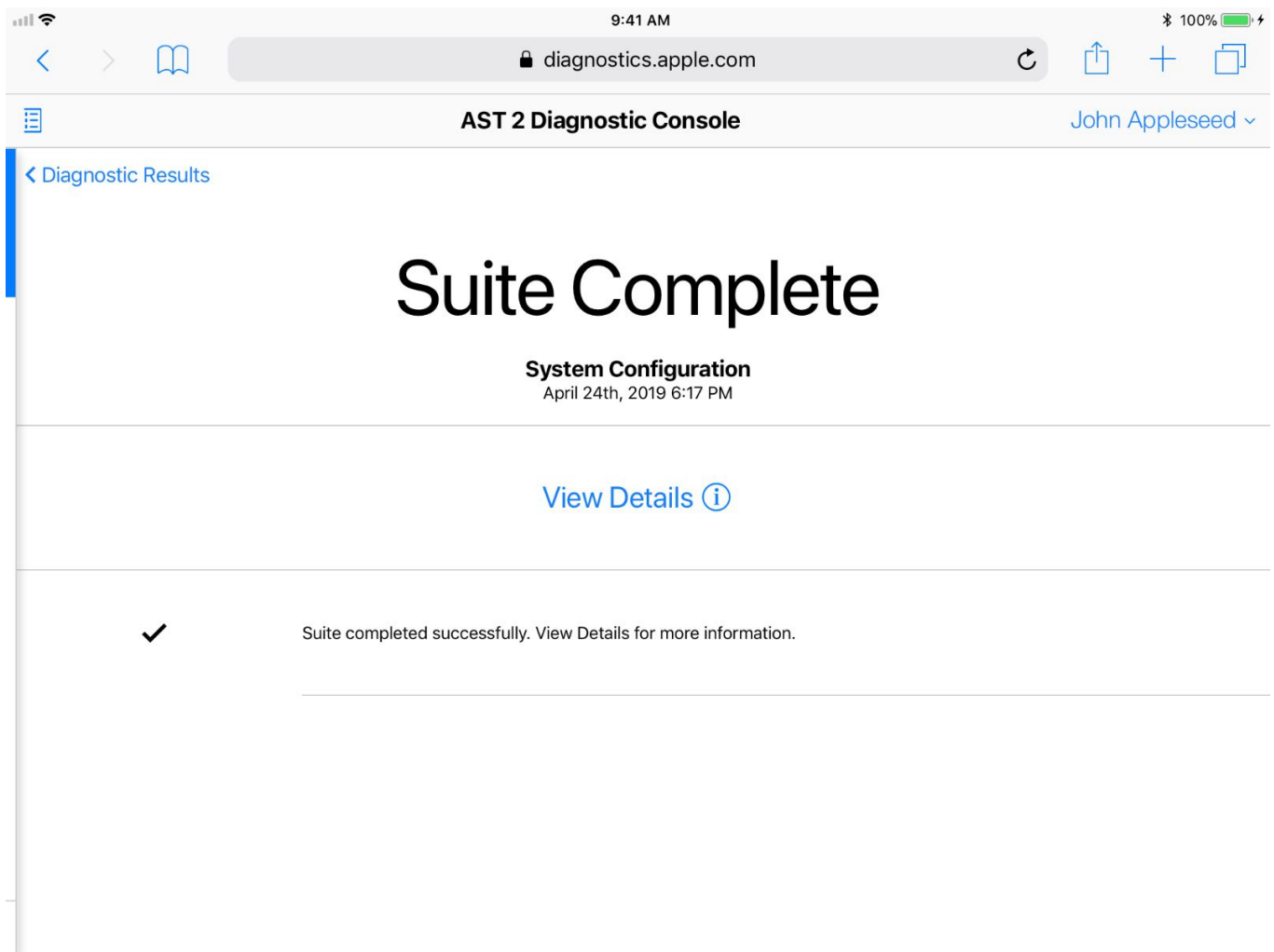
7. Choose the System Configuration suite from the Diagnostic Console.

The screenshot displays the Apple Diagnostic Console web application. At the top, the browser address bar shows 'diagnostics.apple.com'. The page header includes the title 'Diagnostic Console' and a user profile 'John Appleseed'. The main content area is titled 'Diagnostic Suites' and is organized into two sections: 'POST-REPAIR' and 'REPAIR COMPLETION'. The 'POST-REPAIR' section lists two diagnostic suites: 'Full System Diagnostic (EFI)' and 'Full System Diagnostic (OS)'. The 'REPAIR COMPLETION' section lists two suites: 'System Configuration' and 'Trackpad Calibration Check'. The 'System Configuration' suite is highlighted with an orange border. Each suite entry includes an icon, a title, a description, an information icon, a duration, and a right-pointing arrow.

Section	Icon	Suite Name	Description	Info Icon	Duration	Action
POST-REPAIR	Laptop with checkmark	Full System Diagnostic (EFI)	Performs comprehensive testing of hardware functionality and memory module integrity.	ⓘ	30-90 minutes	>
	Laptop with checkmark	Full System Diagnostic (OS)	Performs comprehensive testing of hardware and graphics functionality.	ⓘ	15-30 minutes	>
REPAIR COMPLETION	Gear icon	System Configuration	Completes required configuration of applicable service parts and updates firmware after repair. This suite becomes available after service part serial numbers are saved in a repair. For more information refer to TP1657: System Configuration.	ⓘ	1-10 minutes	>
	Trackpad icon	Trackpad Calibration Check	Verifies calibration of the trackpad actuator and force sensor. This suite must be run each time the computer is opened and reassembled.	ⓘ	3-7 minutes	>

8. Toward the end of the process, the Apple logo and a progress bar will appear.

9. The customer's computer will restart and test results will appear in the Diagnostic Console of AST 2.



Note:

- While the process is running, the customer's display remains blank most of this time.
- Firmware restoration will take about two minutes.

10. If no issues are found:

- Restart the customer's computer and run MRI as well as all applicable diagnostics to complete the repair.
- For notebooks, Trackpad Calibration Check suite must be run any time the computer is opened.

Note: For iMac Pro, macOS needs to be reinstalled. Shut down the desktop and then restart in recovery mode to install the macOS from Internet Recovery.

11. If issues are found and a diagnostic test fails:

- Follow the instructions on the Diagnostic Console.
- Escalate to CSS.

Troubleshooting Tips

If the session does not activate (the gray bar does not turn blue):

1. Verify that the host machine is connected to the internet.
2. Verify the customer's computer is connected to power.
3. Verify the customer's computer is in DFU mode. Refer to [TP1758: Device Firmware Update \(DFU\) mode for Computers with the Apple T2 Security Chip](#).
4. Verify the correct port on the customer's computer is being used.
5. Verify the correct cable is being used.
Note: Do not use USB-C to USB-A cable (923-00504) combined with USB-C to USB Adapter (MJ1M2AM/A).
6. Verify that the serial number of the customer's computer was entered correctly.
7. Verify the parts have been correctly added to the repair.

If the System Configuration suite is not available:

1. Verify parts have been added to the repair.
2. Verify the KBB and KGB serial numbers are correct.

3. Verify the repair has been saved.
4. Archive and recreate the diagnostic session.
5. Restart the host computer.
6. Open the device and confirm that all internal components were properly installed and all flex cables are securely connected.
7. If it has been more than 14 days since parts were added to the repair, escalate to CSS.

If the session is interrupted (the blue bar turns to gray):

1. Archive and recreate the diagnostic session.
2. Check the network connection.
3. Restart the host computer.
4. Verify the host machine is not sleeping.
5. Open the device and confirm that all internal components were properly installed and all flex cables are securely connected.

Connector Types on Logic Board

Connector Types on Logic Board for MacBook Pro (2016, 2017, 2018, 2019)

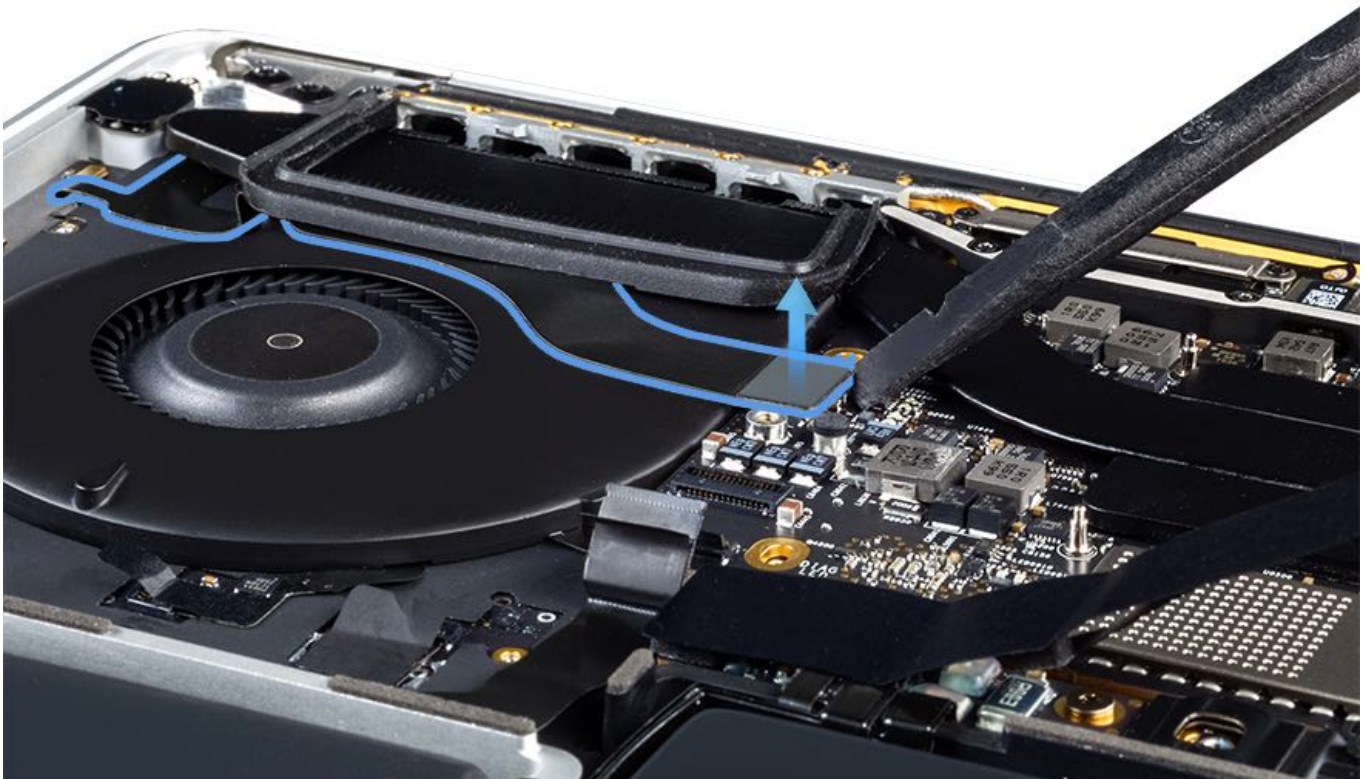
Low-Profile Solid Platform Flex

- Disconnect connector vertically in one motion. The connectors are susceptible to bent pins if rocked from side to side or inserted improperly.
- Reconnect connector by first aligning it over receptacle. Keep connector level with board and press down evenly.

Examples:

- audio flex cable
- trackpad flex cable
- Embedded DisplayPort (eDP) flex cable

[Solid Platform Flex Connectors Video](#)



Locking Lever

- Flip up lever 90 degrees and evenly disconnect cable.
- Lock down lever after inserting cable.
- Close lever when handling or shipping a logic board module, whether a known-good or a known-bad board.

Below are examples of components that have locking levers:

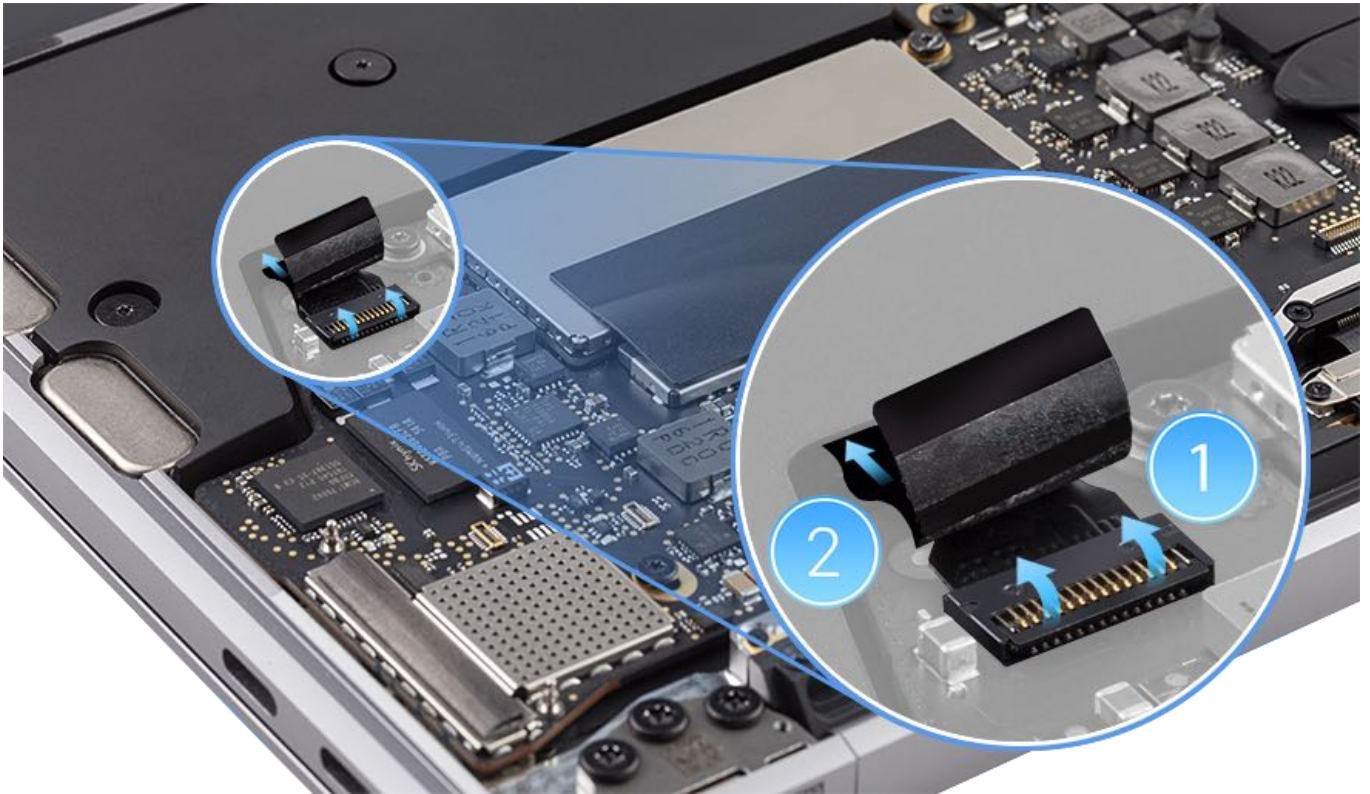
- speakers
- keyboard flex cable
- fan
- battery flex cable



Caution: The locking levers on the logic board are fragile. To protect the levers during handling or shipment of the logic board, close the levers after the cables are disconnected. Once the logic board is installed in the top case and the cables are

connected, be sure to lock down the levers again.

[Locking Lever Connectors Video](#)



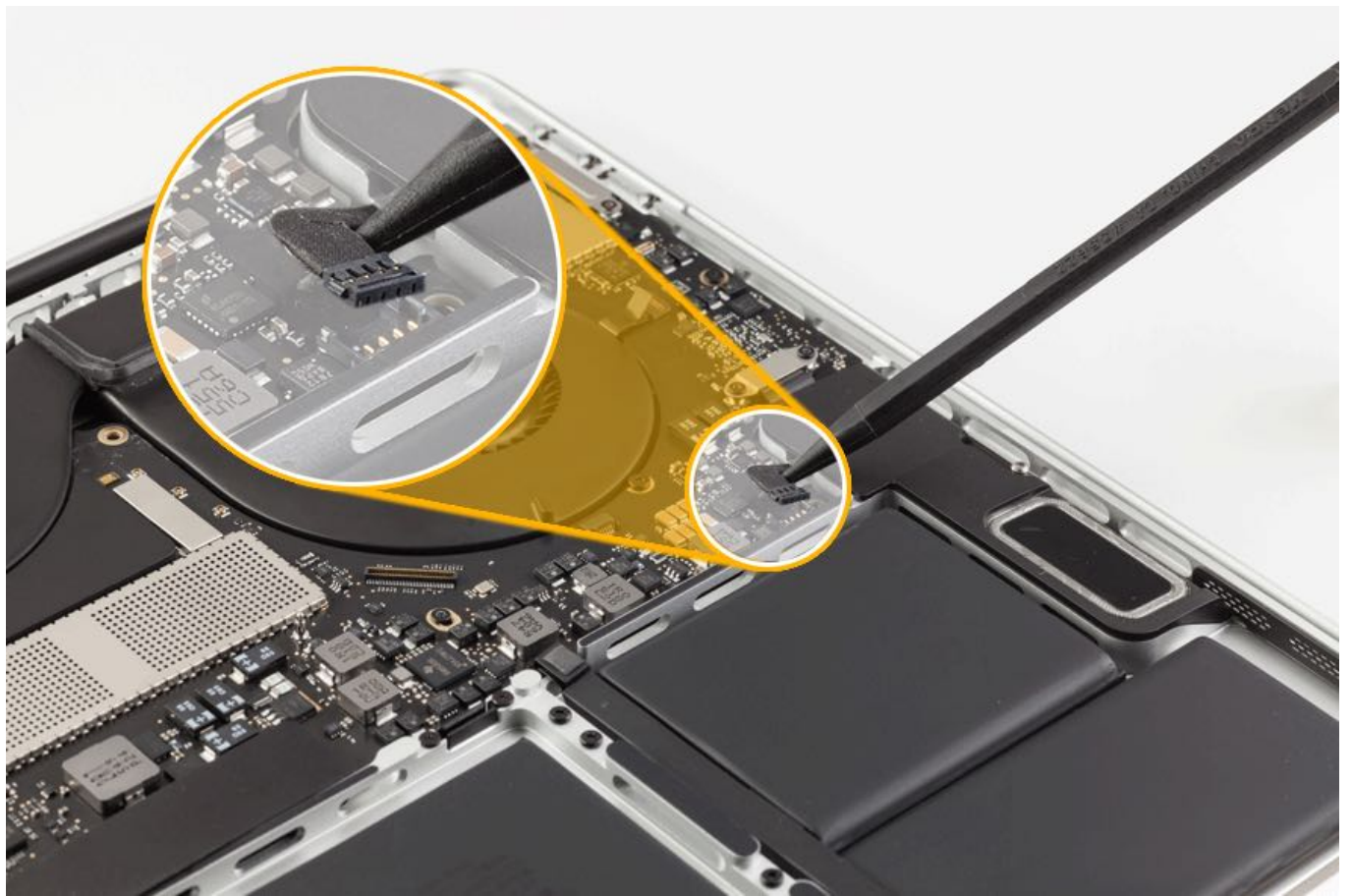
Vertical Insertion (JST)

MacBook Pro (15-inch, 2016, 2017, 2018, 2019) only

Below is an example of how to disconnect and reconnect a vertical insertion connector:

- Use a black stick under the cable to remove.
- Keep the connector level to the board when disconnecting and reconnecting.
- Press evenly when reconnecting or connector can be tipped up and not fully seated.
 - Right speaker
 - Left speaker

[Japan Solderless Terminal \(JST\) Connectors Video](#)



Tools and Fixtures

Tools and Fixtures for MacBook Pro (2016, 2017, 2018, 2019)

The following tools are required:

- Clean, soft, lint-free cloth
- ESD-safe workstation, including an ESD mat and wrist or heel strap
- ESD bags (for storing ESD-sensitive parts while removed from the unit)
- ESD-safe tweezers for wireless cables or antenna tool (923-01322)
- Suction cup (922-8252)
- Pentalobe screwdriver (923-0731)
- Torque driver (blue), 0.65 kg-fcm (923-0448)
- 1IPR security bit (923-0247) for use with the Torque driver (923-0448)
- Phillips #00 screwdriver (magnetized)
- Torx T3 screwdriver (magnetized)
- Torx T4 screwdriver (magnetized)
- Torx T5 screwdriver (magnetized)
- Torx T8 screwdriver (magnetized)
- Black stick or other nonconductive nylon or plastic flat-blade tool (922-5065)
- Thermal grease syringe (922-7144)
- Isopropyl alcohol (IPA) wipe (included with heat sink and logic board)
- Magnifying glass (for reading serial number)
- Keycap lever (923-01803)
- Keycap tool kit (076-00337) includes: Keycap slider tool, keycap lever, Kapton tape, and precut VHB adhesive strips.

Caution: To prevent scratches or other cosmetic damage to the computer housing, use a soft cloth as a protective layer when removing and installing the external screws.

Bottom Case Fixture

- Bottom case removal/install fixture kit (076-00290), which includes:
 - Bottom case fixture
 - Quick grip clamps (2), also available separately (923-01369)
 - Nonslip gloves, small (pair), also available separately (923-01371)
 - Nonslip gloves, extra large (pair), also available separately (923-01370)



- Nonslip gloves, medium/large (pair), only available separately (923-01368), not part of the kit

Battery Covers

- MacBook Pro (13-inch, 2016 and 2017, Two Thunderbolt 3 Ports): 923-01318



- MacBook Pro (13-inch, 2016 and 2017, Four Thunderbolt 3 Ports): 923-01319



- MacBook Pro (13-inch, 2018 and 2019, Four Thunderbolt 3 Ports): 923-02533



- MacBook Pro (15-inch, 2016 and 2017): 923-01320



- MacBook Pro (15-inch, 2018 and 2019): 923-02532

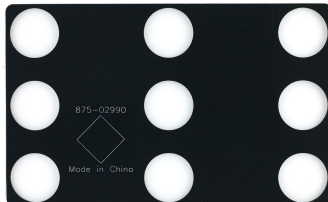


Trackpad Tools

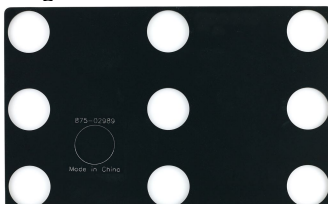
- Trackpad calibration weights, 200g and 800g (923-00462)



- Weight Placement Rubber Template (923-01316) for MacBook Pro (13-inch, 2016, 2017, 2018, 2019)

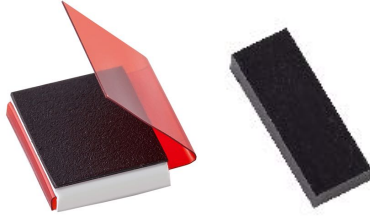


- Weight Placement Rubber Template (923-01317) for MacBook Pro (15-inch, 2016, 2017, 2018, 2019)



Touch ID Tools

- Touch ID alignment tool kit (923-01586)



For MacBook Pro (13-inch, 2016 and 2017, Four Thunderbolt 3 Ports) and MacBook Pro (15-inch, 2016 and 2017) only

- Data transfer tool kit (076-00236)



- Logic board holder (923-01130)



Take Apart Procedure Notes

Reassembly Steps

When no replacement steps are listed, replace parts in exact reverse order of Removal procedure.

Note About Images in This Guide

In some cases a pre-production model may have been used to document the procedures in this guide. Although there may be small differences in appearance between the image pictured and the computer you are servicing, the procedures are the same unless noted.

Screw Sizes

All screw sizes shown are approximate and represent the total length of the screw.



Bottom Case

First Steps



Warning:

- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

Important:

- Only Apple-certified technicians should perform this procedure. For more information, refer to [OP1859: About Apple service certifications](#).
- Follow ESD guidelines. Refer to [OP100: Electrostatic Discharge Precautions and Myths](#).
- Read [TP772: Battery Safety Setup](#) before performing this procedure.

Before you begin:

- Shut down the computer.
- Unplug all cables.
- Put on an ESD wrist strap.
- Place the computer facedown on a clean, flat surface.

For video instruction, refer to [SV306: Bottom Case Replacement Video](#).



Tools

- ESD wrist strap
- Pentalobe screwdriver (923-0731)
- Battery cover:
 - 923-01318 for MacBook Pro (13-inch, 2016, 2017, and 2019, Two Thunderbolt 3 Ports)

- 923-01319 for MacBook Pro (13-inch, 2016 and 2017, Four Thunderbolt 3 Ports)
- 923-02533 for MacBook Pro (13-inch, 2018 and 2019, Four Thunderbolt 3 Ports)
- 923-01320 for MacBook Pro (15-inch, 2016 and 2017)
- 923-02532 for MacBook Pro (15-inch, 2018 and 2019)
- Bottom case removal kit (076-00290)
- Fine-tip permanent marker
- Suction cup (922-8252)
- Clean, soft, lint-free cloth (not shown)

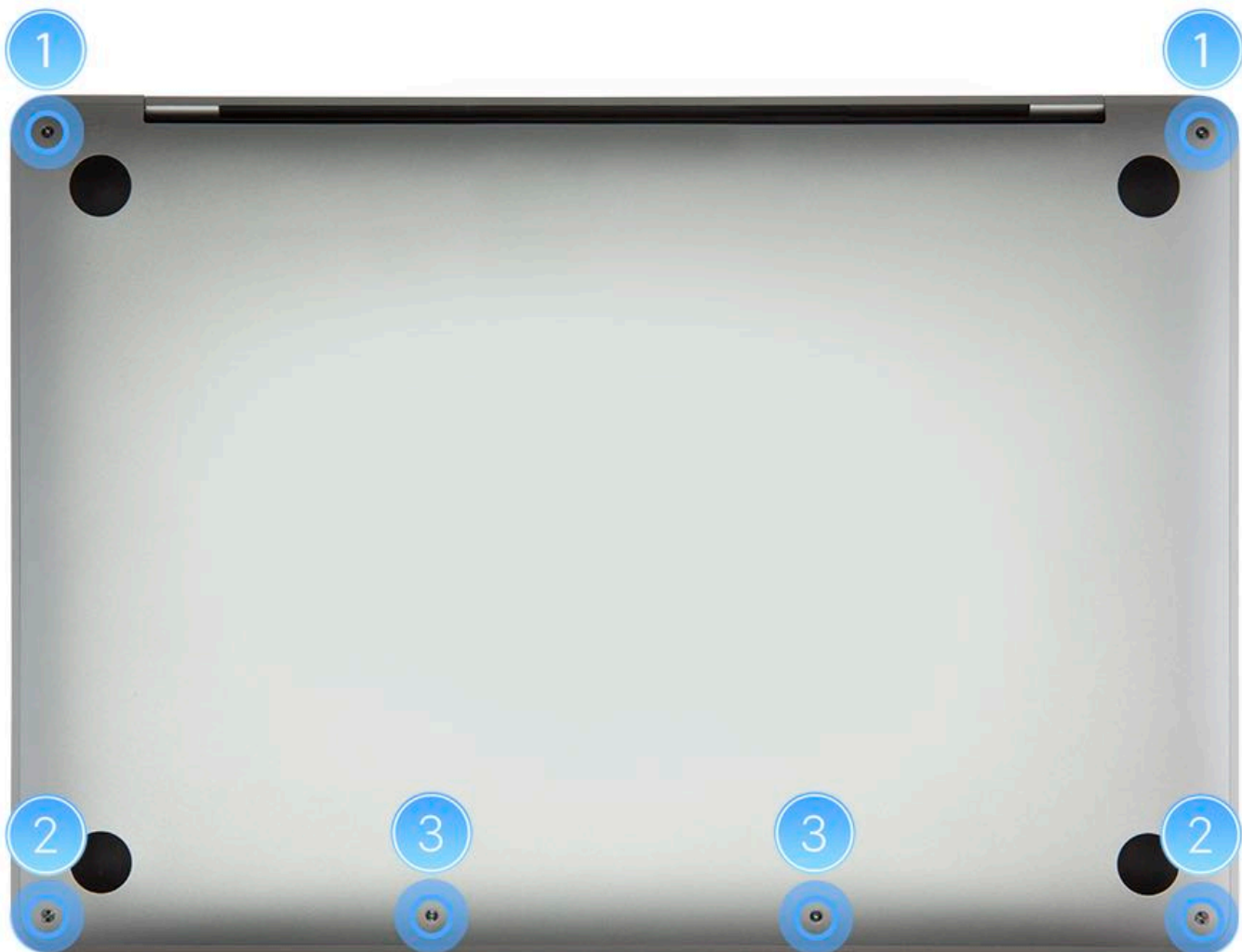


Steps For Removal

1. Remove the six Pentalobe screws in any sequence.

MacBook Pro (13-inch, 2016 and 2017, Two Thunderbolt 3 Ports)			
Color	Screw #1	Screw #2	Screw #3
Space Gray	923-01299 	923-01097 	923-01095 
Silver	923-01099 	923-01100 	923-01098 
MacBook Pro (13-inch, 2019, Two Thunderbolt 3 Ports)			
Color	Screw #1	Screw #2	Screw #3
Space Gray	923-03198 	923-03199 	923-03200 
Silver	923-03201 	923-03202 	923-03203 

MacBook Pro (13-inch, 2016, 2017, and 2019, Two Thunderbolt 3 Ports)



MacBook Pro (13-inch, 2016, 2017, 2018, 2019, Four Thunderbolt 3 Ports)

Color	Screw #1	Screw #2
Space Gray	923-01096 	923-01413
Silver	923-01415 	923-01431

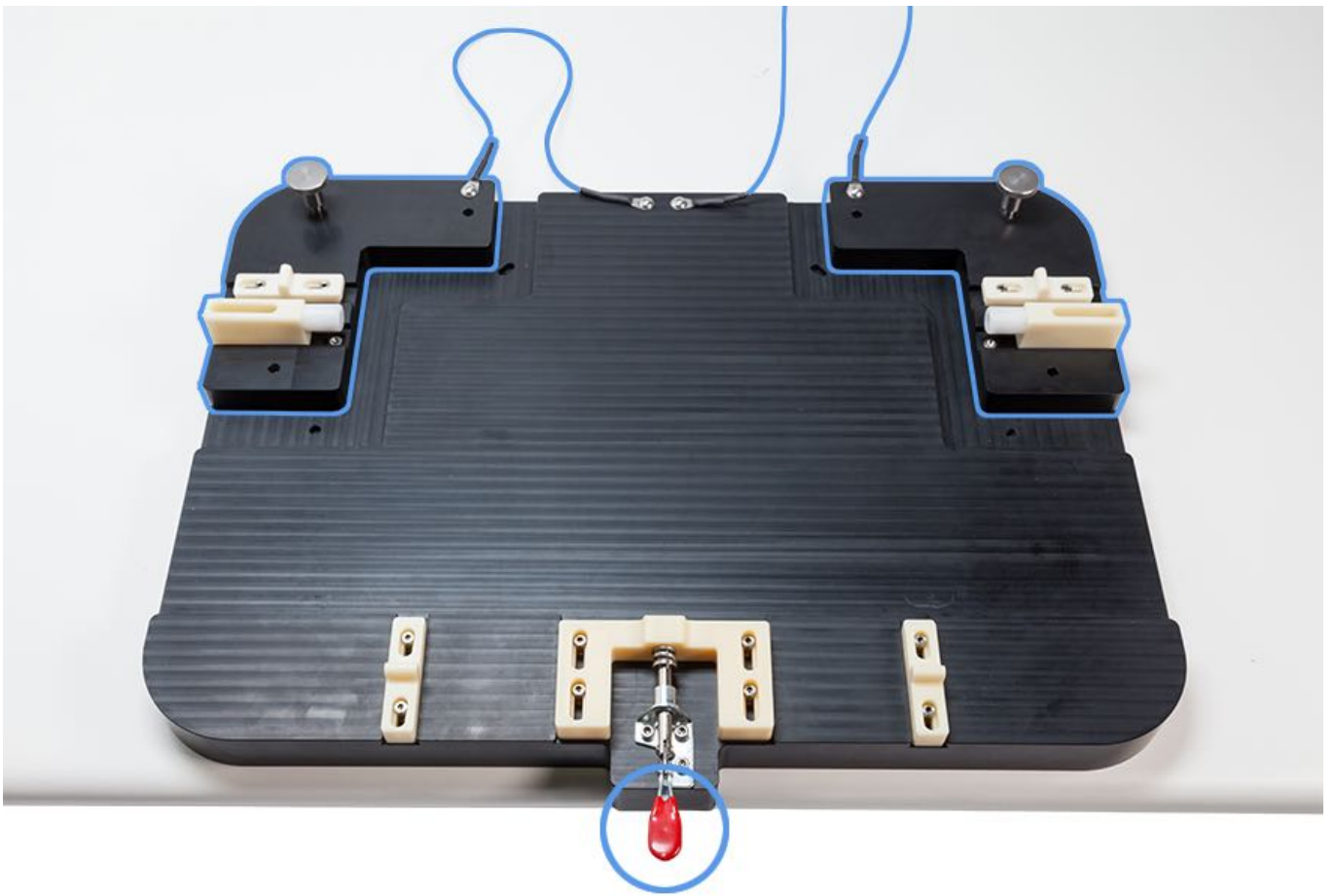
MacBook Pro (15-inch, 2016, 2017, 2018, 2019)

Color	Screw #1	Screw #2
Space Gray	923-01514 	923-01513
Silver	923-01517 	923-01516

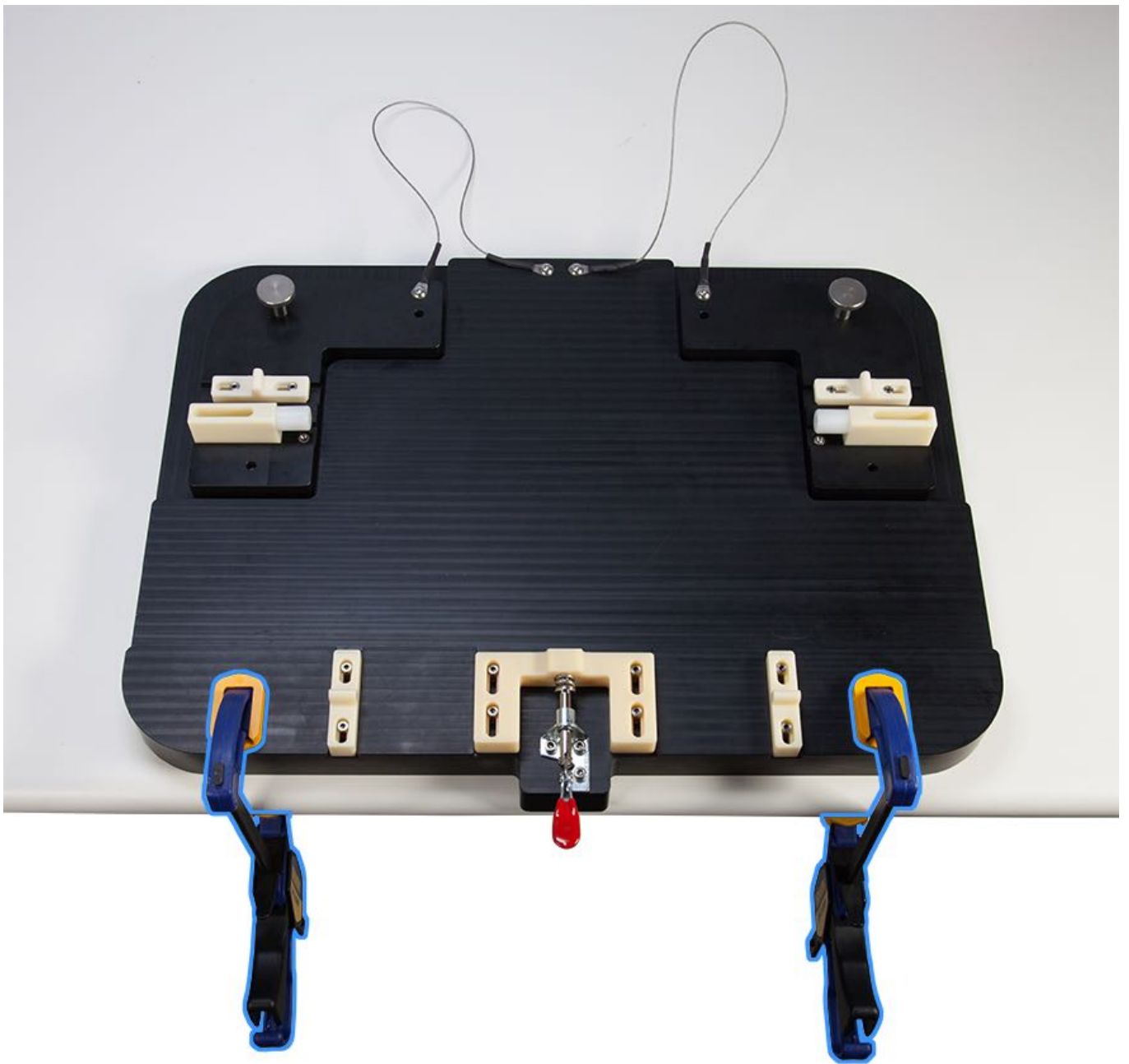
MacBook Pro (13-inch, 2016, 2017, 2018, 2019, Four Thunderbolt 3 Ports) and MacBook Pro (15-inch, 2016, 2017,



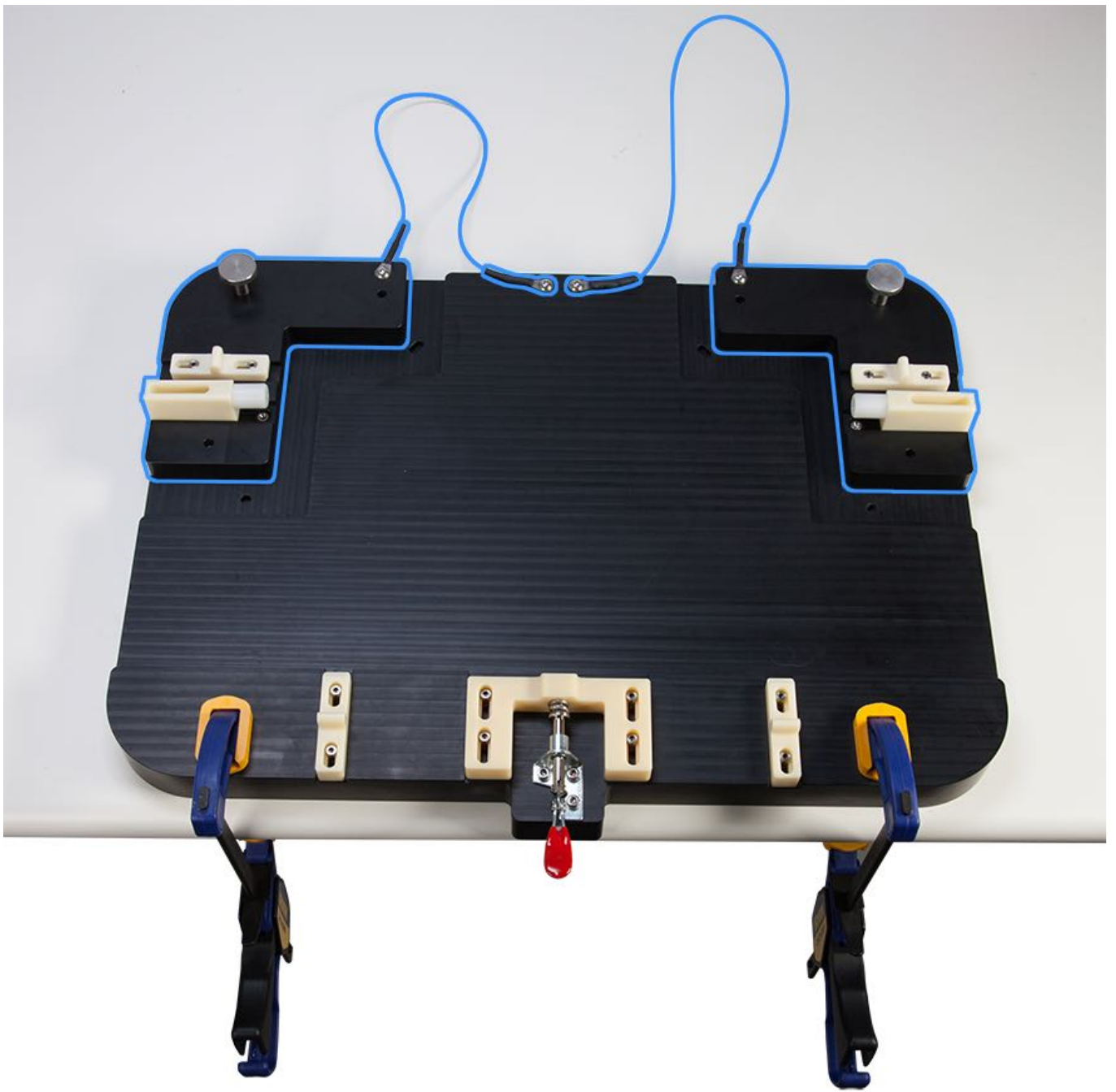
2. Position the bottom case fixture so that the red lever is at the bottom and the tethered corner braces are at the top.



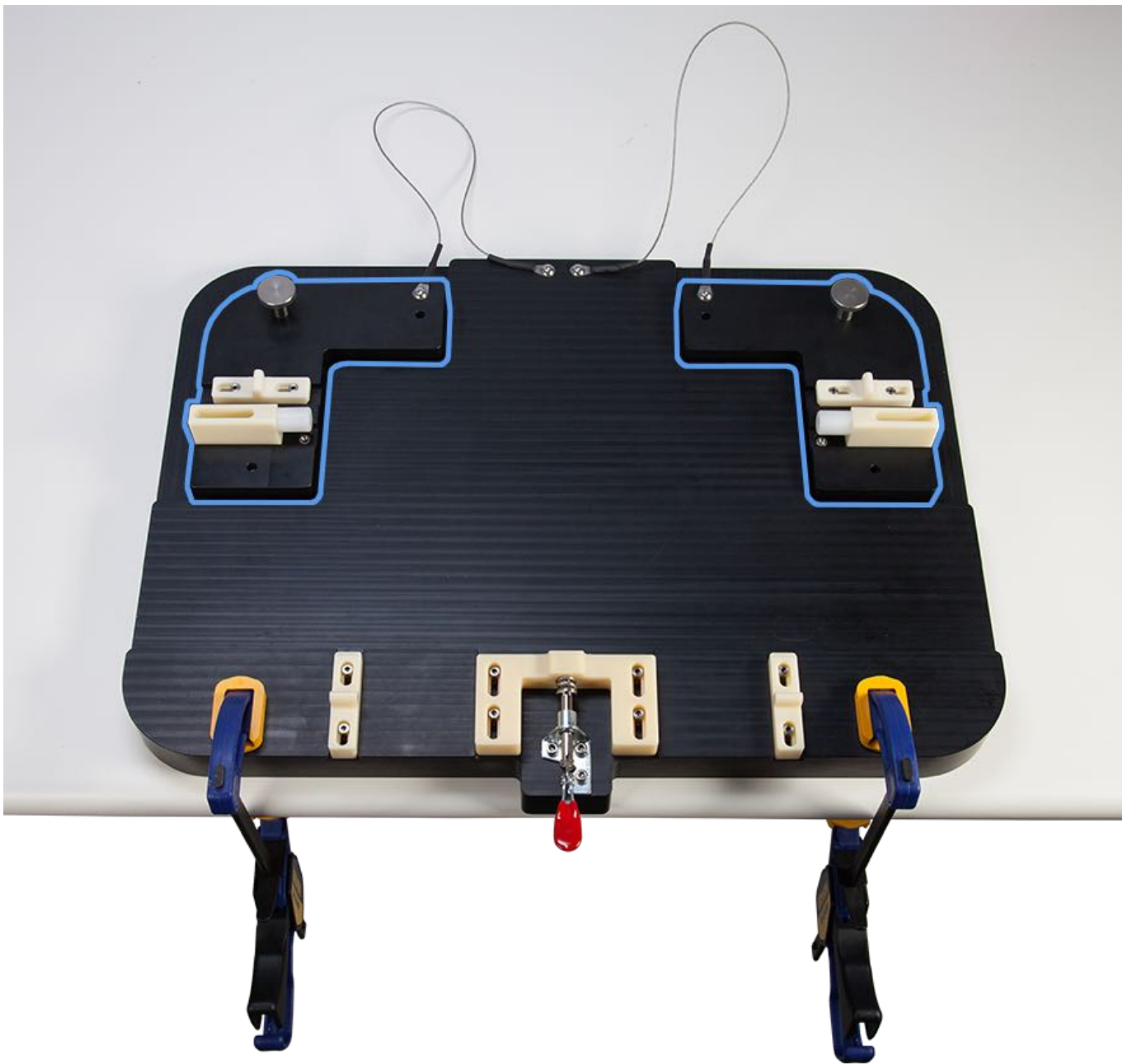
3. Use two clamps to secure the bottom case fixture to the table. Squeeze the clamp handles to tighten them. Make sure that the sliding bars of the clamps are below the table.



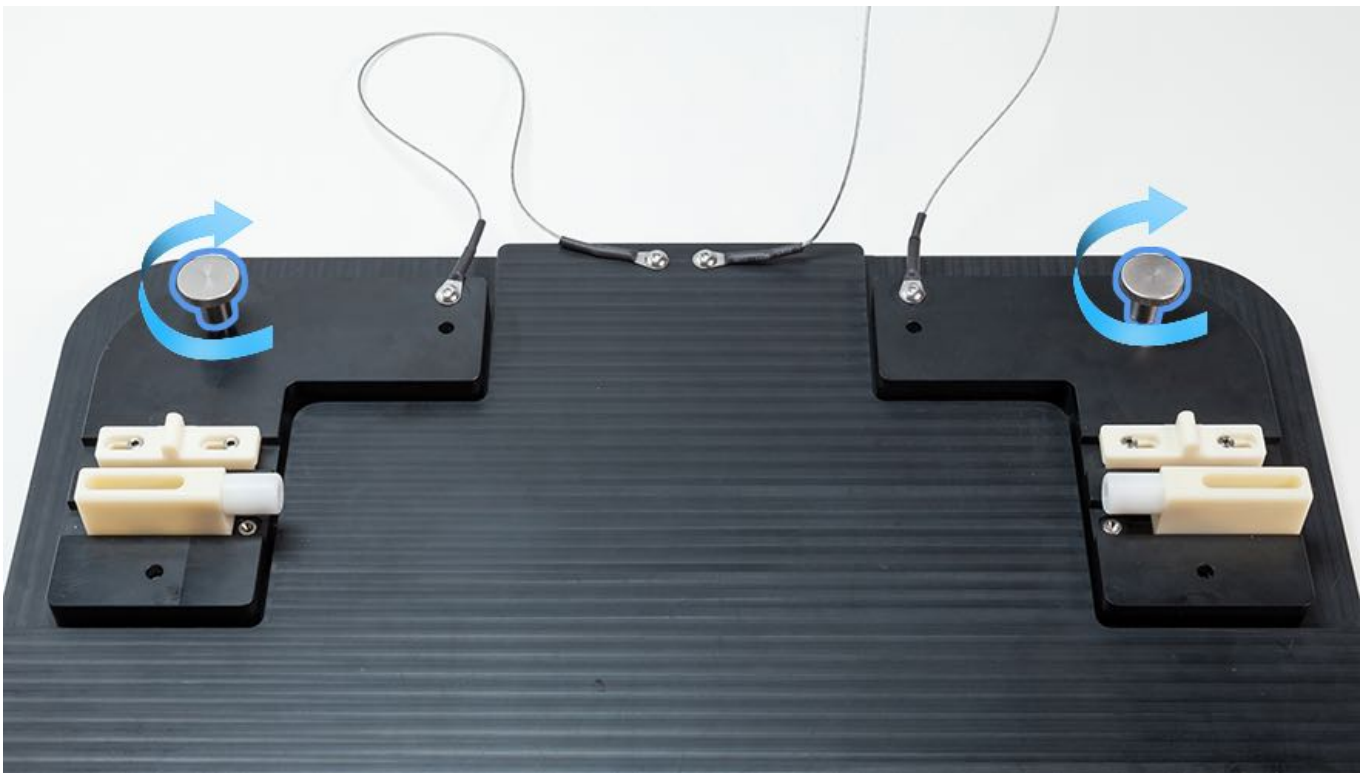
4. Unscrew and position the corner braces to accommodate either a 13-inch or 15-inch computer. Move the braces outward for a 15-inch model, as shown.



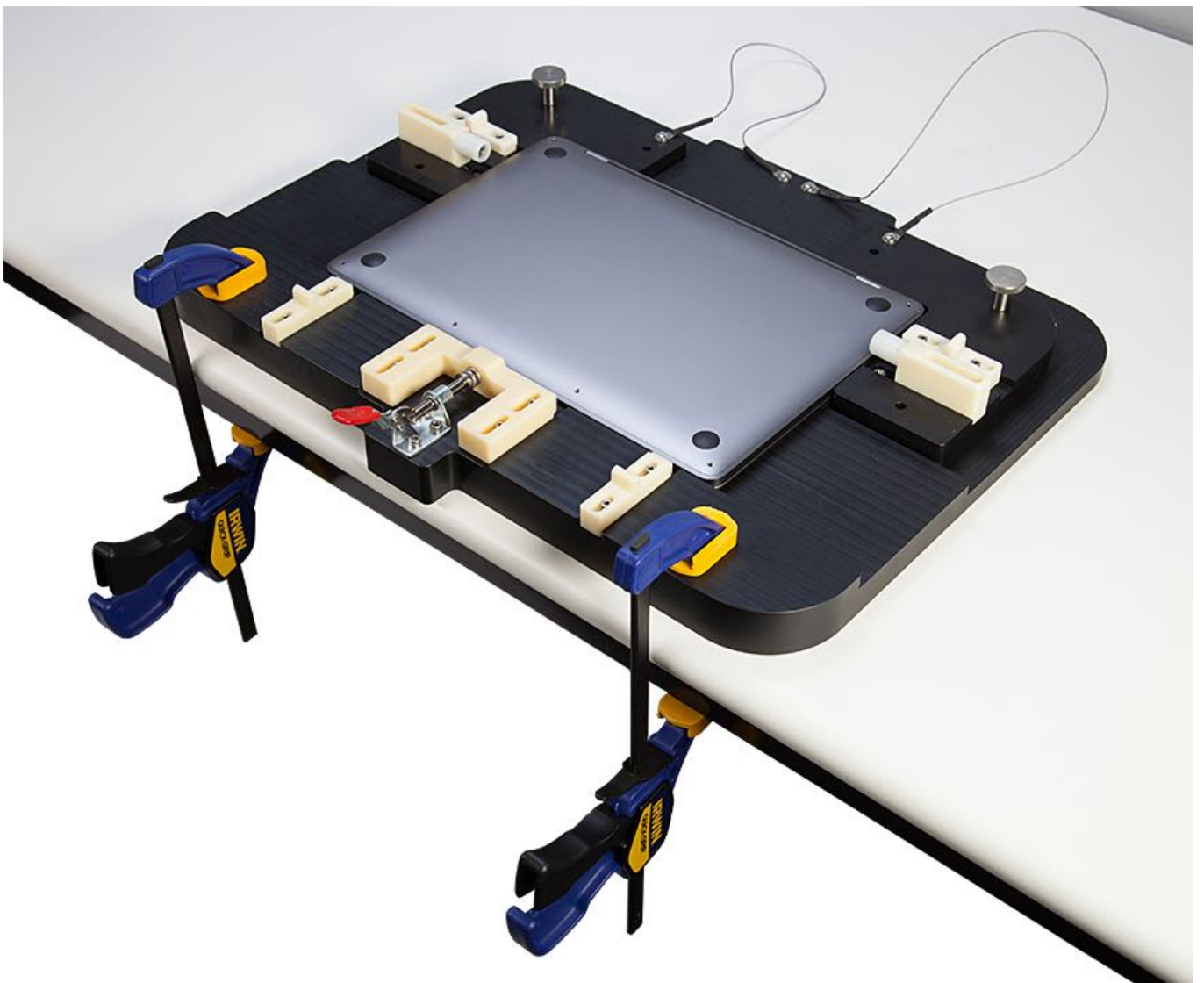
5. Move the braces inward for a 13-inch model, as shown.



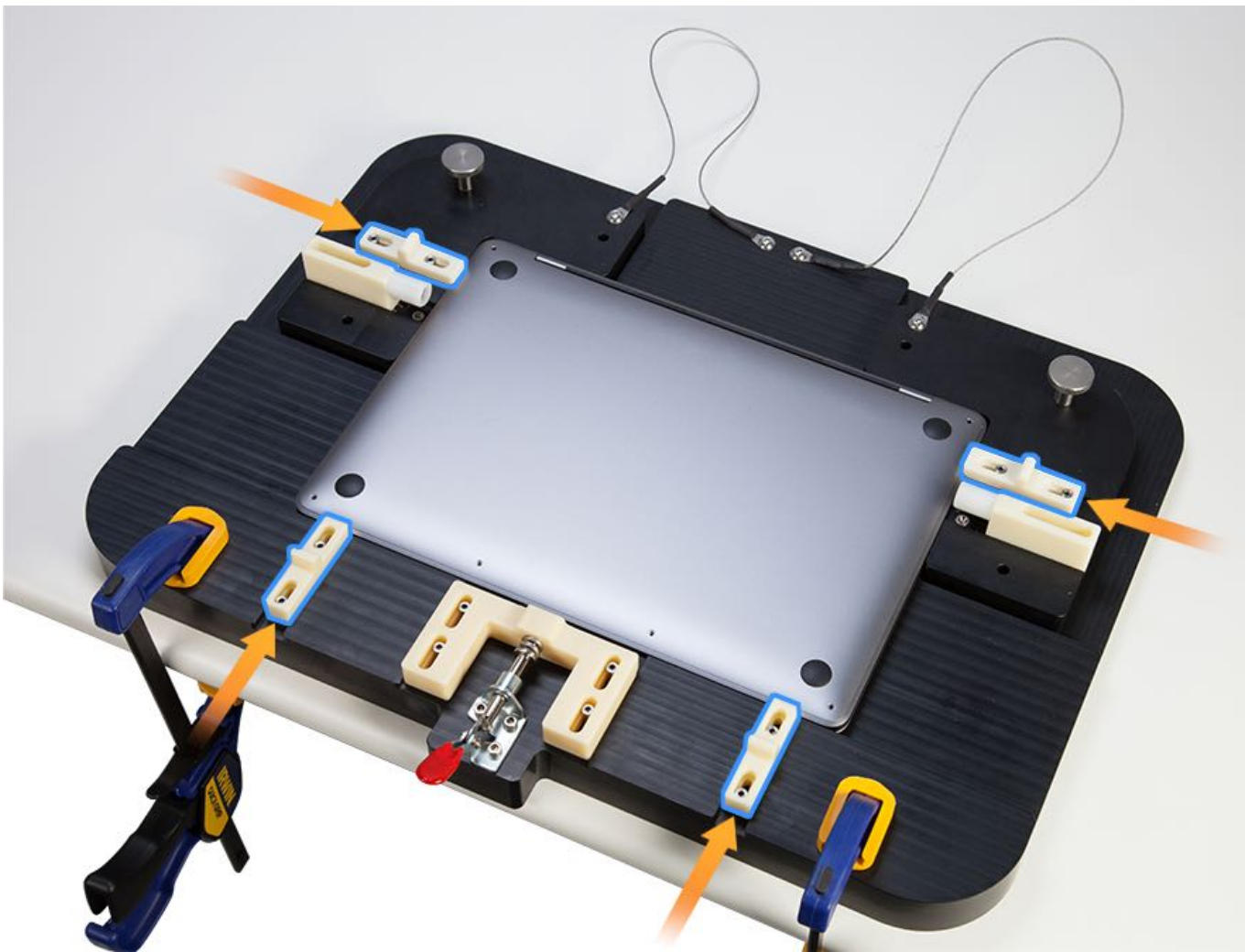
6. Once the corner braces are set, tighten the silver thumbscrews.



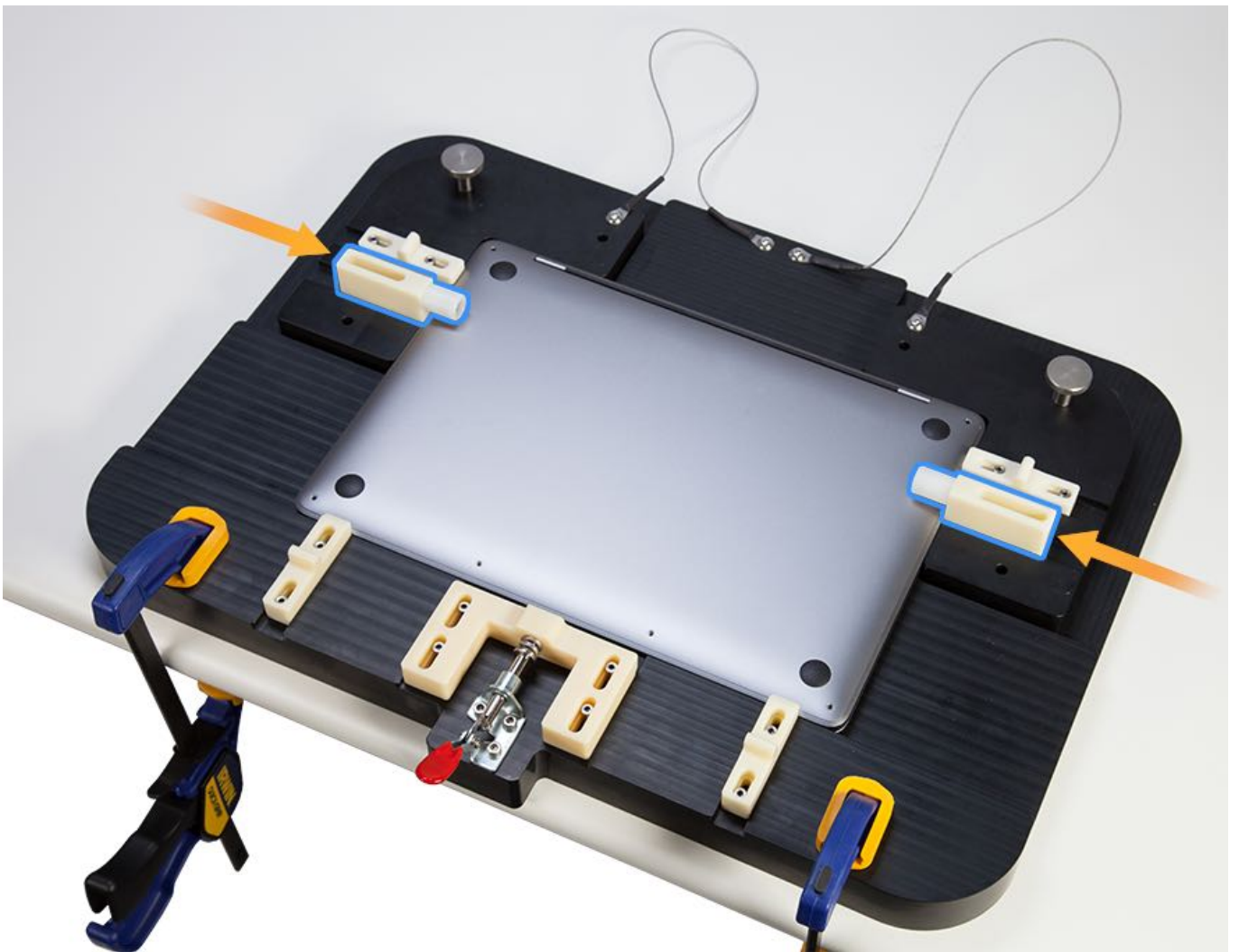
7. Place the computer in the fixture so that the bottom case is faceup and the display hinge is at the top.



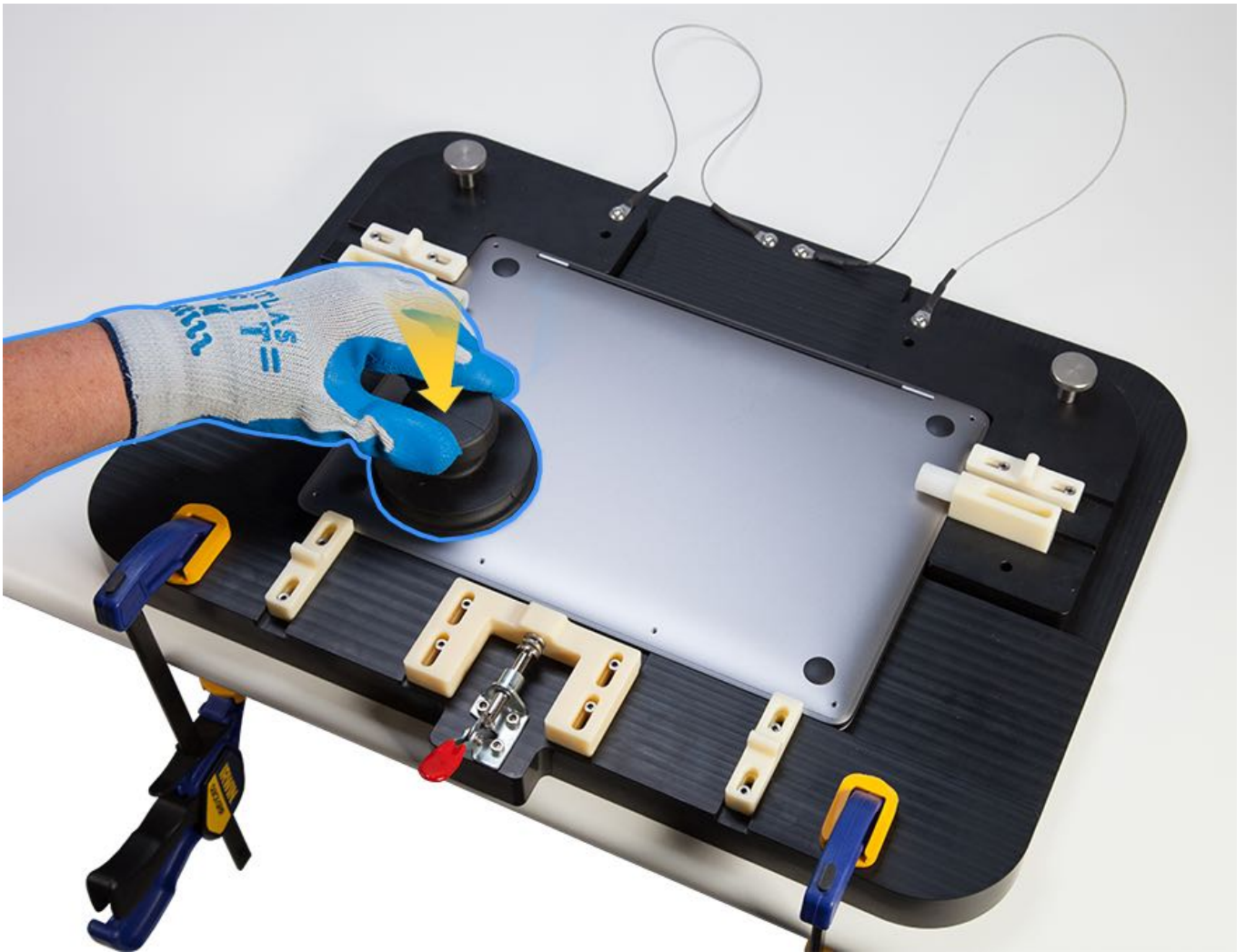
8. Push the four sliding locks inward to hold the computer in place. Ensure the red lever is fully open.



9. Press the two rollers inward. They prevent the bottom case from tilting too far upwards.

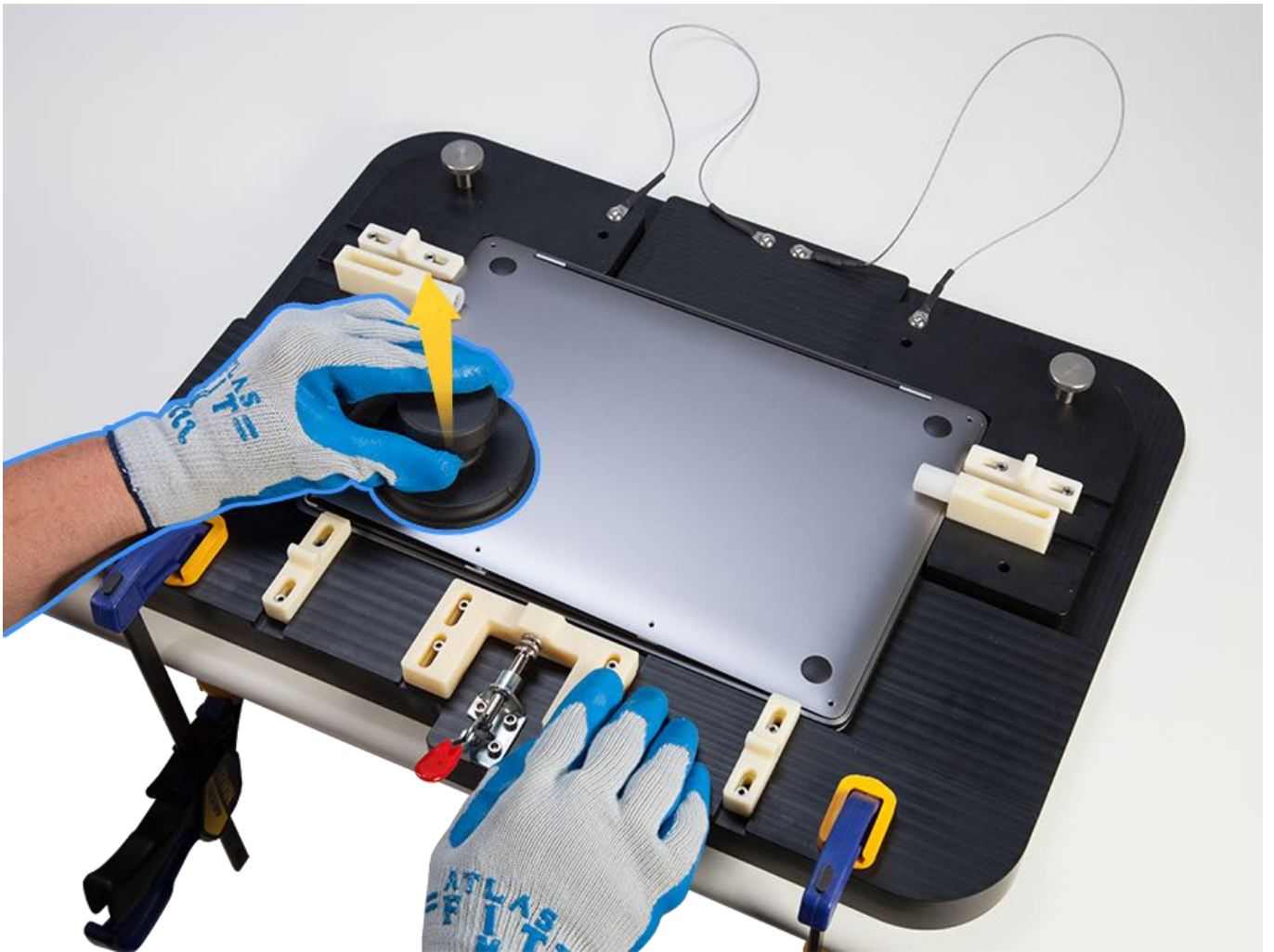


10. Put on the pair of gloves and attach the suction cup at the lower left corner of the bottom case.

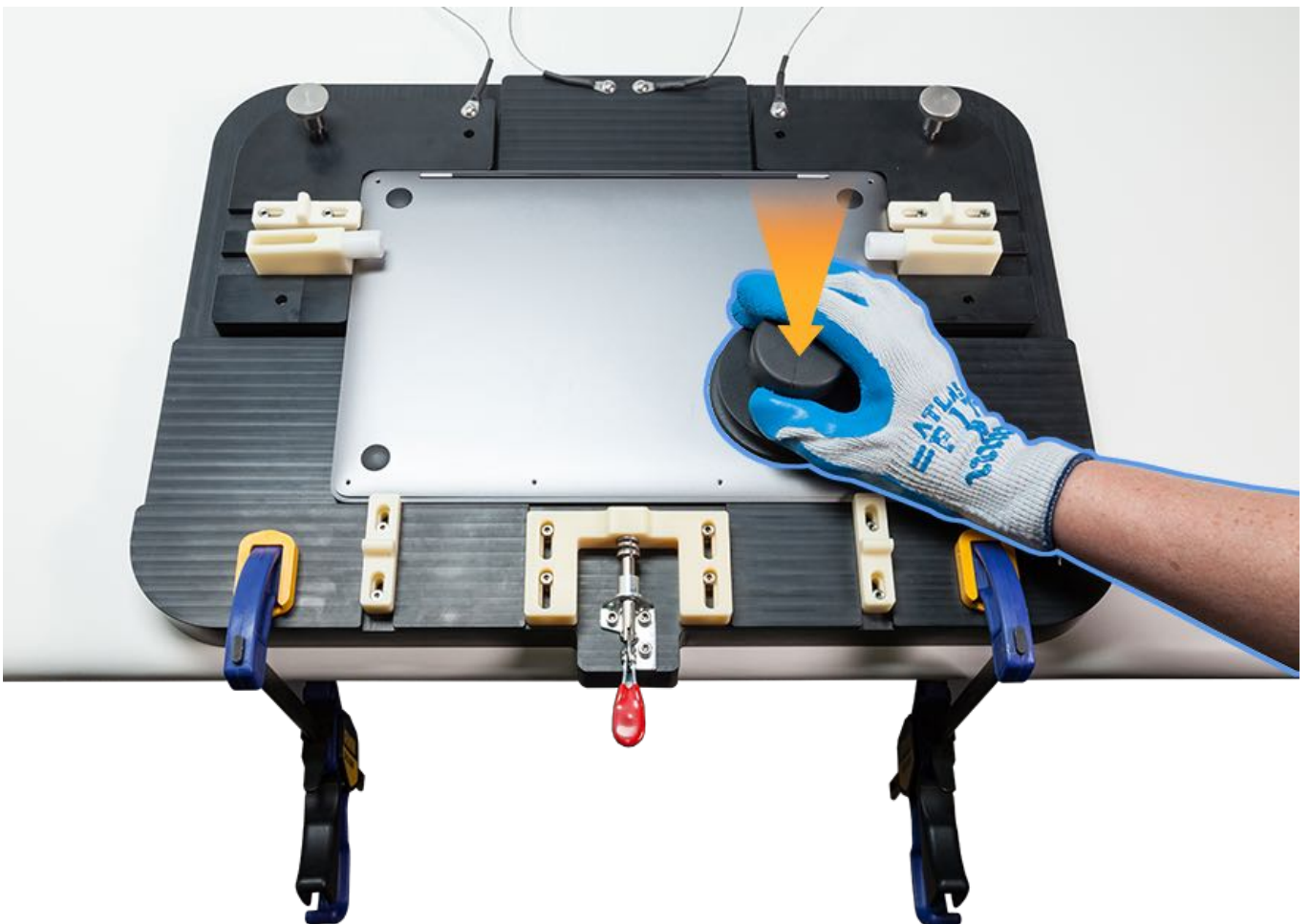


11. Pull up on the suction cup about half a centimeter (0.5 cm), just high enough to lift the bottom case and release two snaps.

Caution: Do **not** insert a black stick into the opening. Using a black stick could damage the battery.



12. Move the suction cup to the lower right corner.



13. Pull up the suction cup to release the remaining two snaps.



14. Remove the suction cup. Then insert your index fingers into the narrow opening at the edges closest to you.



15. To protect the computer assembly, keep the opening no more than a finger's width apart.



16. Position both hands so that they are braced in the recessed areas of the fixture. Bracing your hands allows more leverage and protects the internal components when you remove the bottom case.



17. Pull the bottom case toward you.

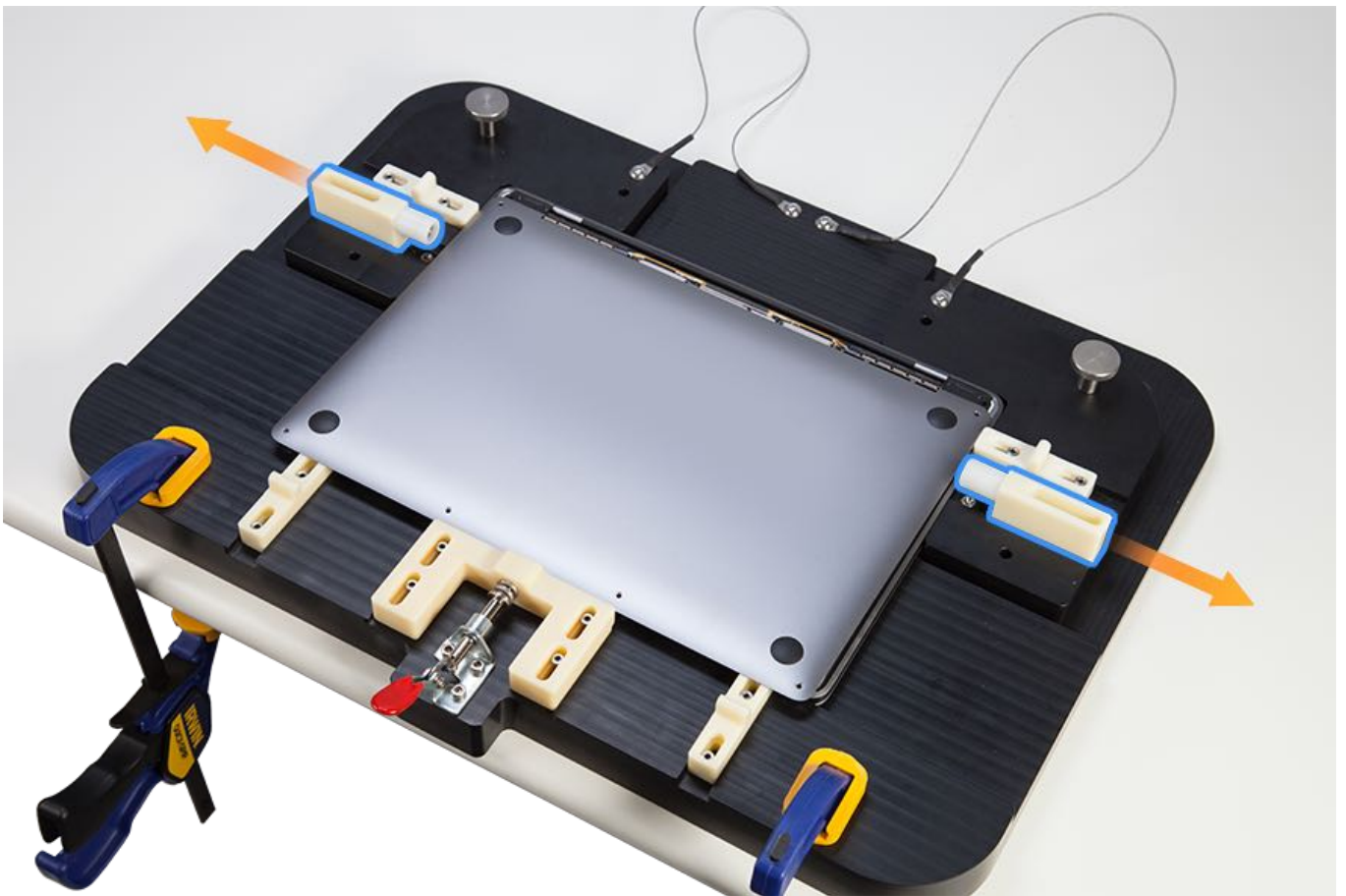
Caution: The spring fingers that secure the bottom case can release suddenly. To prevent the bottom case from sliding over sensitive components, apply gentle and steady pressure to slide the case less than one centimeter.



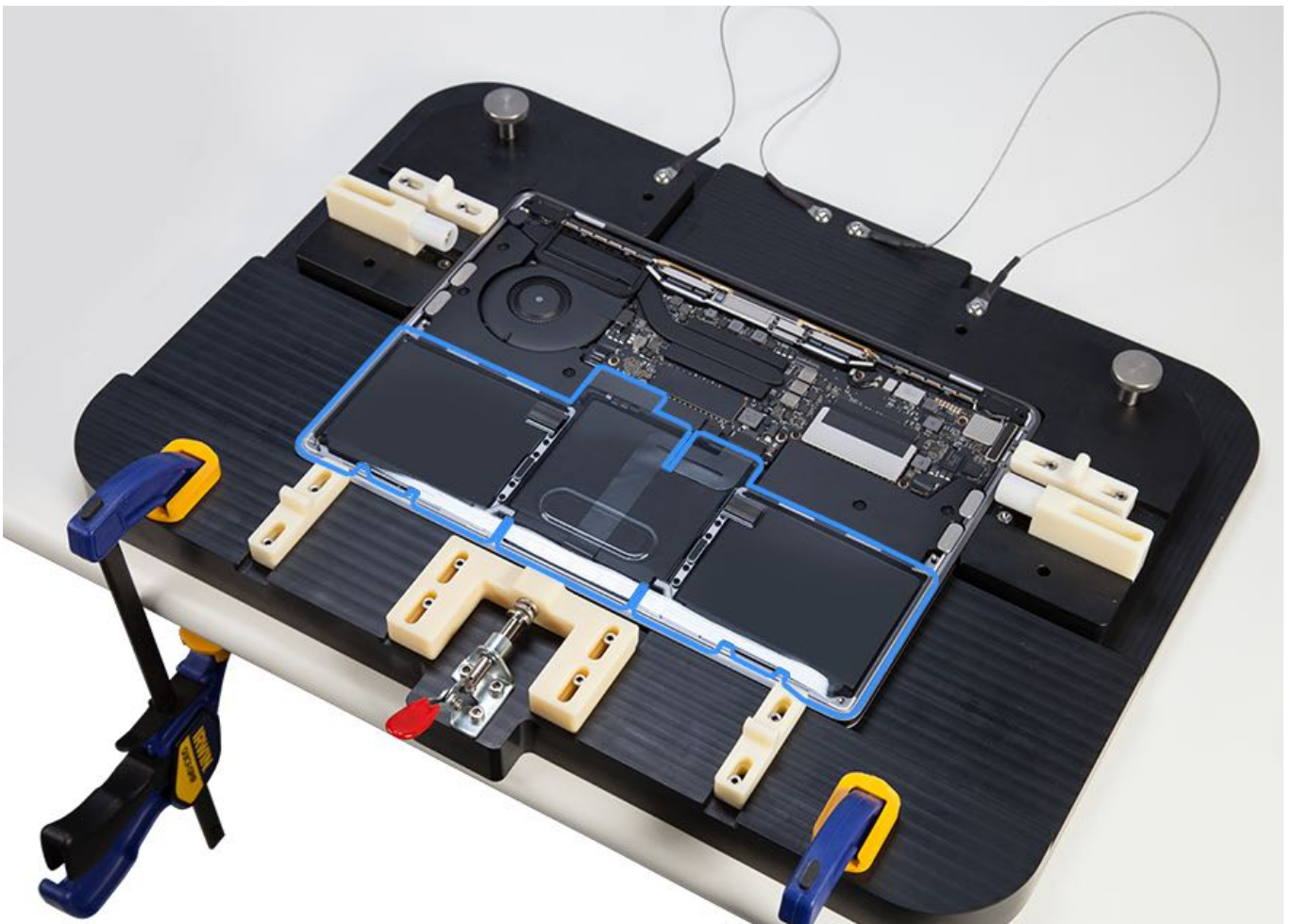
18. Once the spring fingers are disengaged, let the bottom case rest on the computer assembly.



19. Remove the gloves, disengage the two rollers, and remove the bottom case from the fixture.

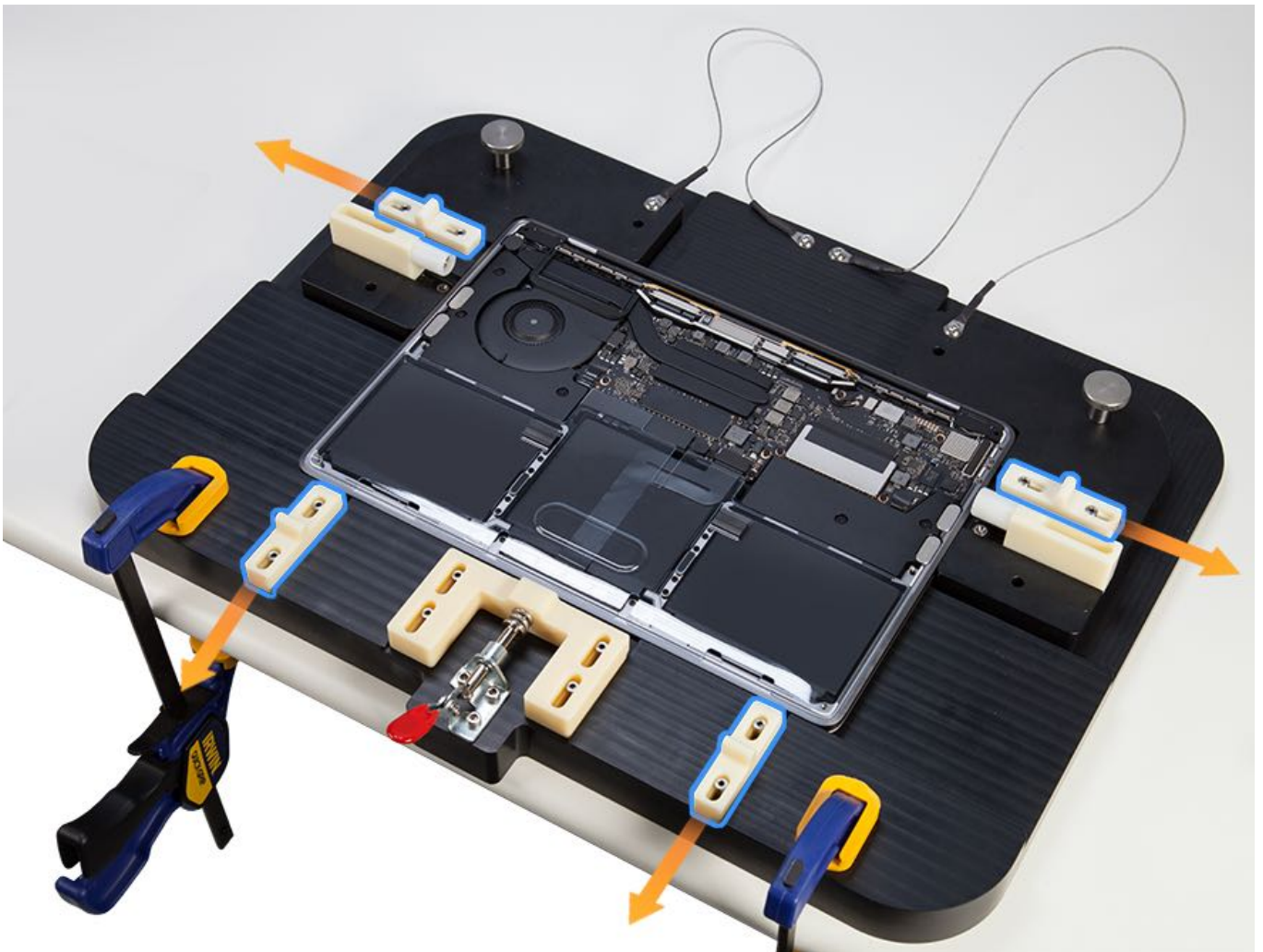


20. Place the protective battery cover on the battery. (The image below shows the 13-inch model.)



21. If you are replacing just the bottom case, go to the reassembly instructions. If you are performing an additional repair on the computer, do not perform that repair while the unit is on the bottom case fixture. Instead, perform the following steps:

- Release the four sliding locks, then lift the computer from the bottom case fixture.
- Transfer the computer to an ESD-safe surface.



22. Refer to one of the following articles to disconnect the battery:

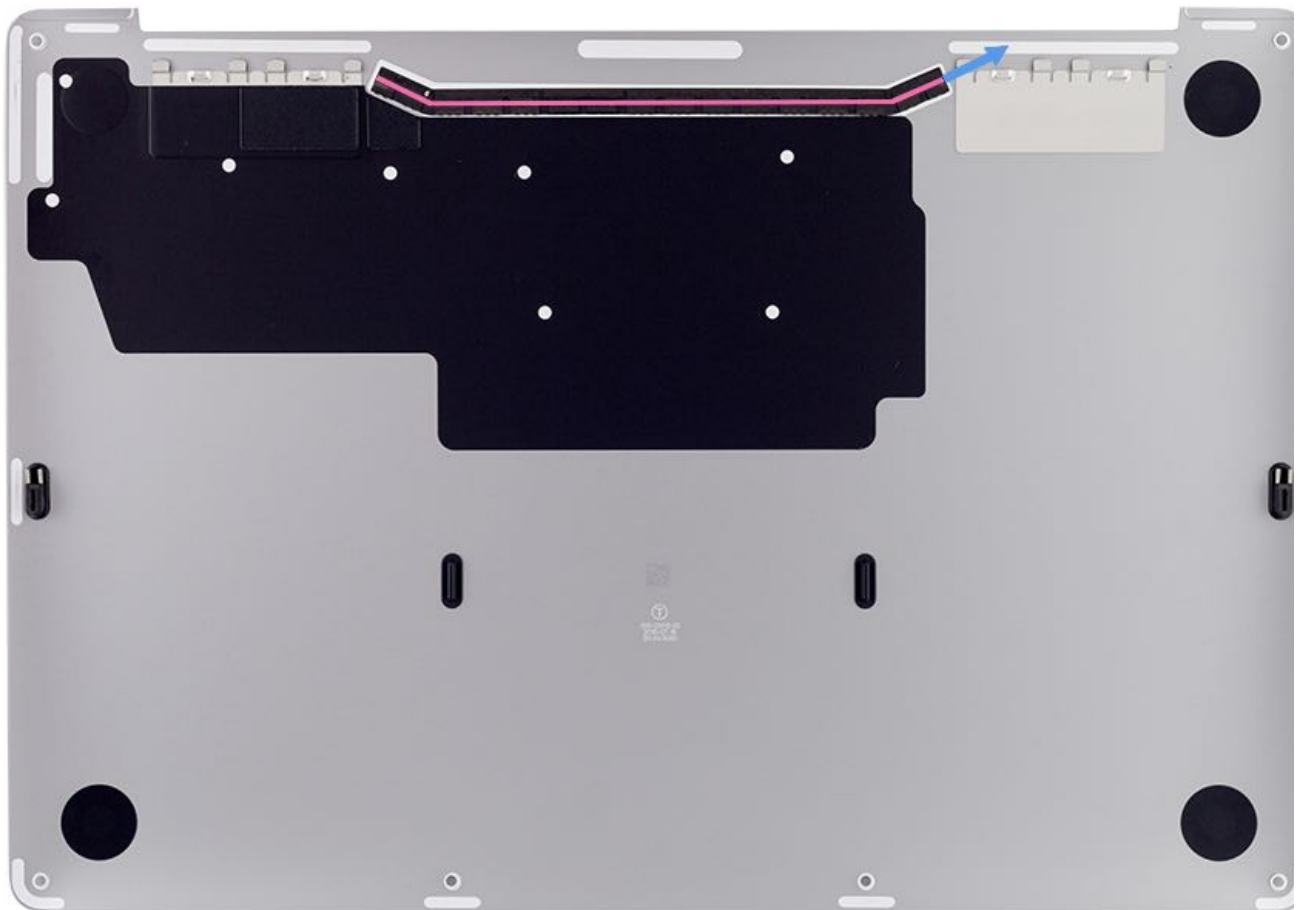
- [MacBook Pro \(13-inch, 2016 and 2017, Two Thunderbolt 3 Ports\): Battery Cover and Disconnecting the Battery](#)
- [MacBook Pro \(13-inch, 2019, Two Thunderbolt 3 Ports\): Battery Cover and Disconnecting the Battery](#)
- [MacBook Pro \(13-inch, 2016, 2017, 2018, 2019, Four Thunderbolt 3 Ports\): Battery Cover and Disconnecting the Battery](#)
- [MacBook Pro \(15-inch, 2016, 2017, 2018, 2019\): Battery Cover and Disconnecting the Battery](#)

Steps For Reassembly

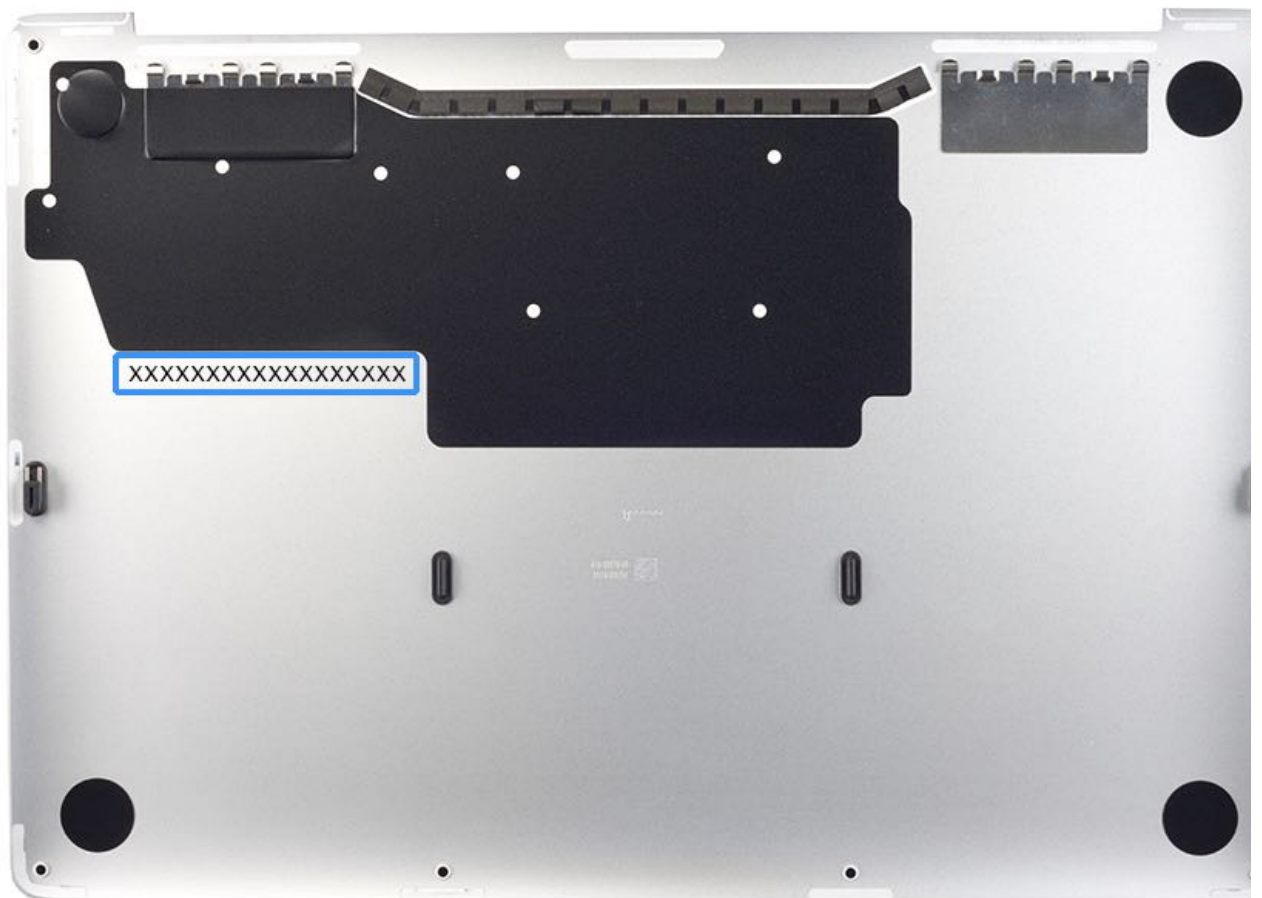
Note: Before ordering a replacement bottom case for MacBook Pro (15-inch, 2018 and 2019), refer to [TP1721: Repair Requirements based on Graphics Configuration](#) to find out how to determine the correct part number.

1. Before installing a new bottom case, do the following:

- Check the replacement bottom case for a red tube that runs through the air loops. Grasp one end of the red tube and pull it out of the air loop strip. The tube is used only during shipment and should be discarded.

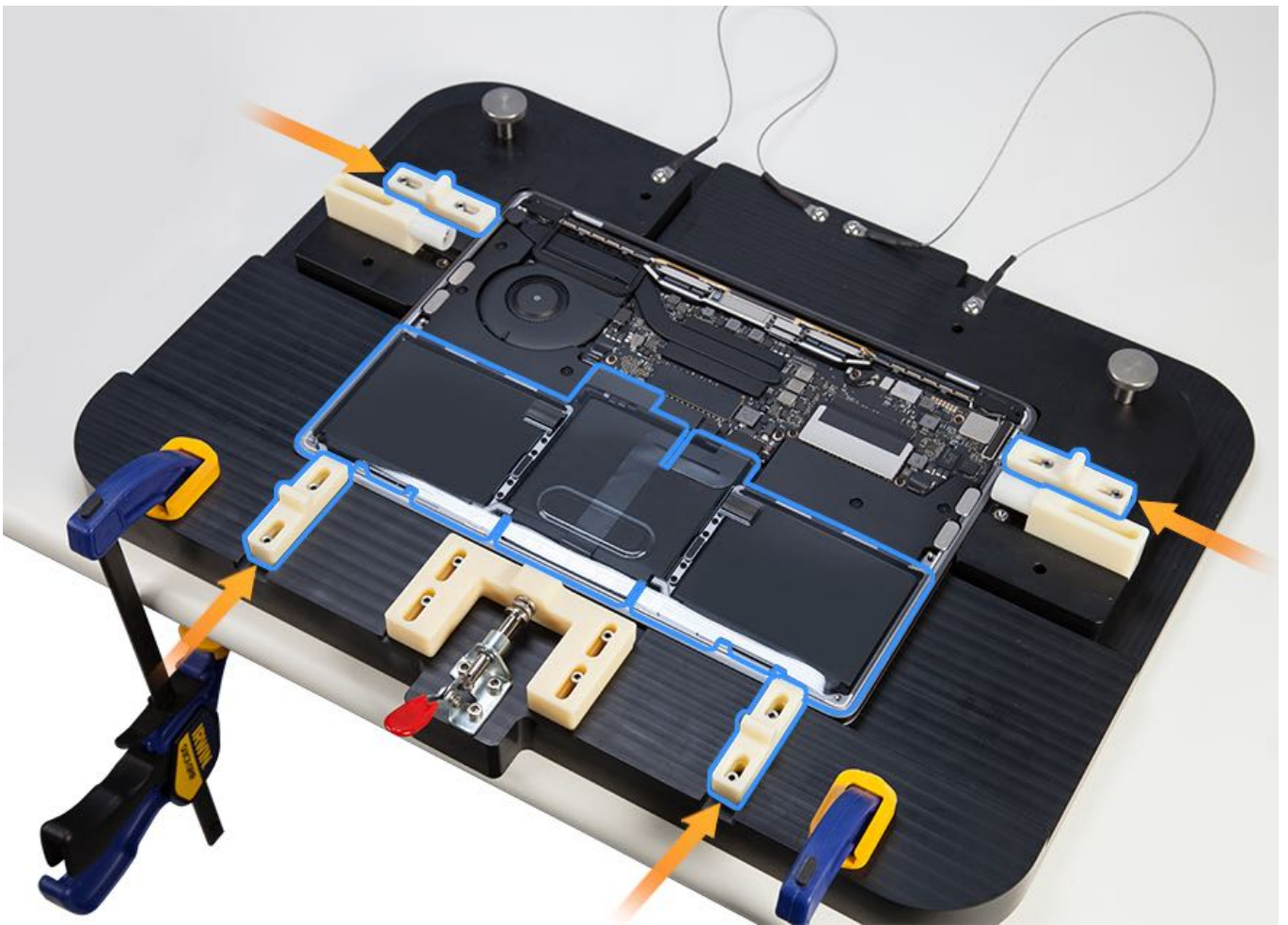


- Retain the original bottom case until the repair is complete. Use a fine-tip permanent marker to write the system serial number on the inside of the replacement bottom case.

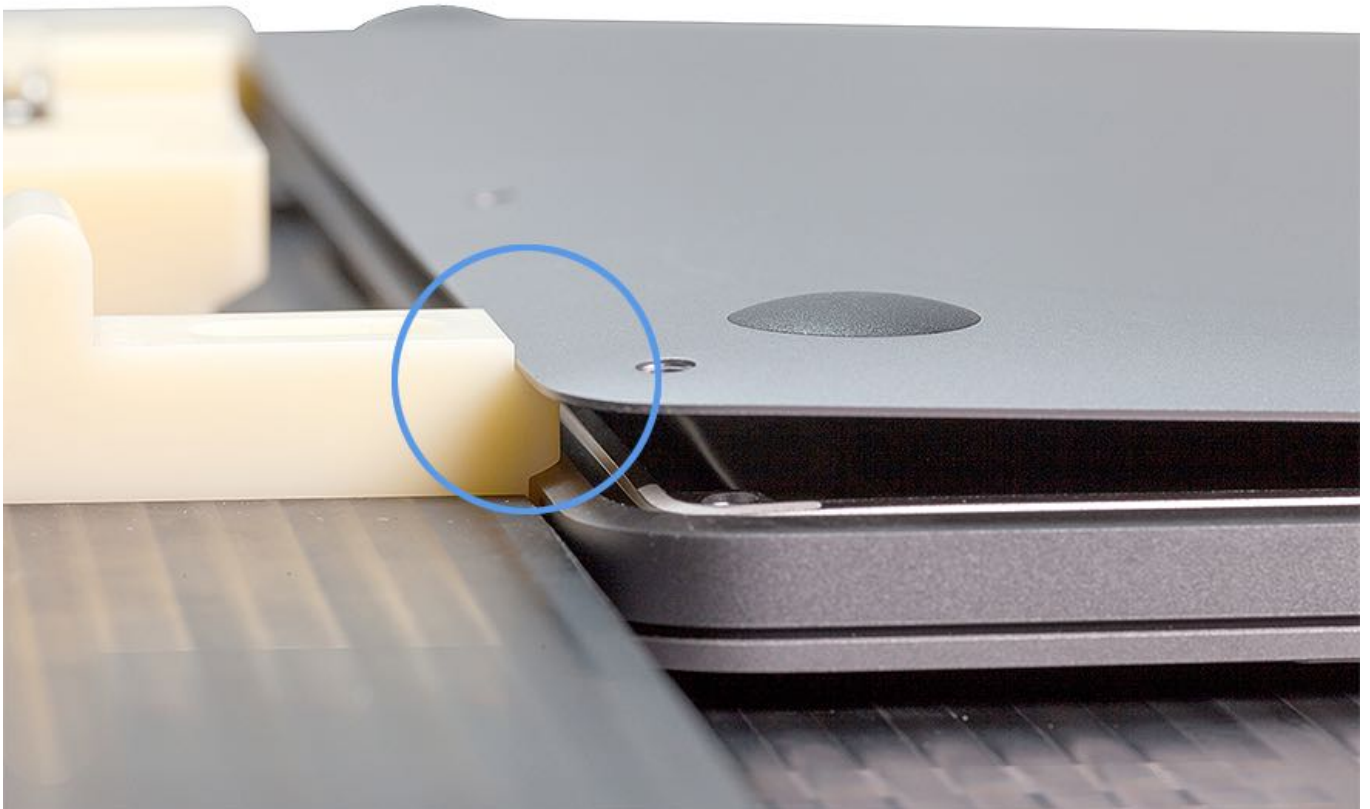




2. Reconnect the battery cable. Then place the computer on the bottom case fixture, making sure the display hinge is away from you.
3. Engage the four sliding locks— **not** the two rollers.
4. Remove the battery cover.



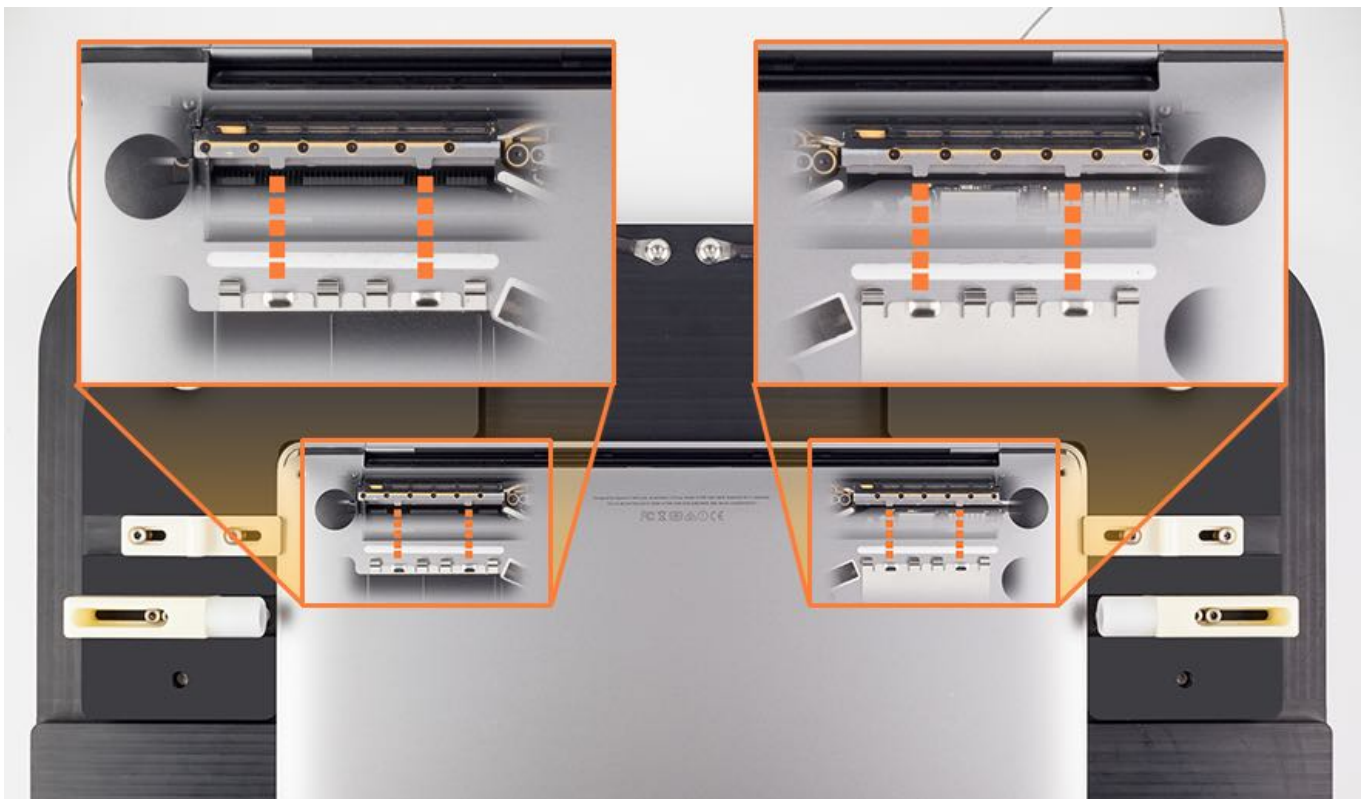
5. Position the bottom case so that its front edge rests on the shelf of the lower two sliding locks.



6. Align the back of the bottom case with the vent/antenna module. The alignment is correct when you can feel that the long edge of the bottom case is flush with the smooth plane of the vent/antenna module.

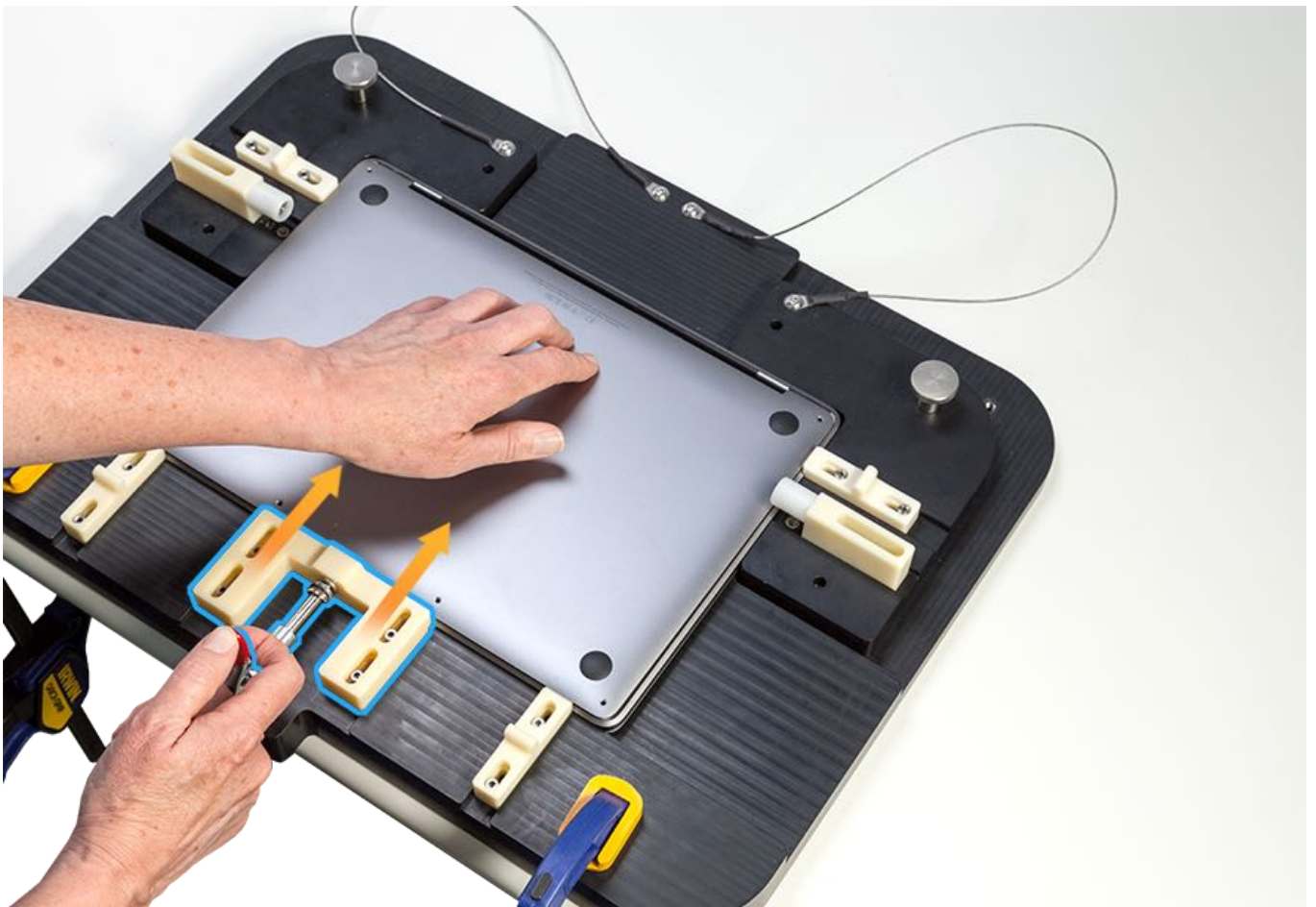


Important: When set up correctly, the notches at each rear corner show an equal gap. Likewise, if the bottom case were transparent, the two rows of spring fingers inside the bottom case would start to align with the metal tabs on the vent wall.



7. Hold light pressure near the back center edge of the bottom case while slowly engaging the red lever. Feel the spring fingers engage slightly as you press down on the bottom case.

Caution: Pushing the red lever all the way can distort the bottom case and the lever spring.

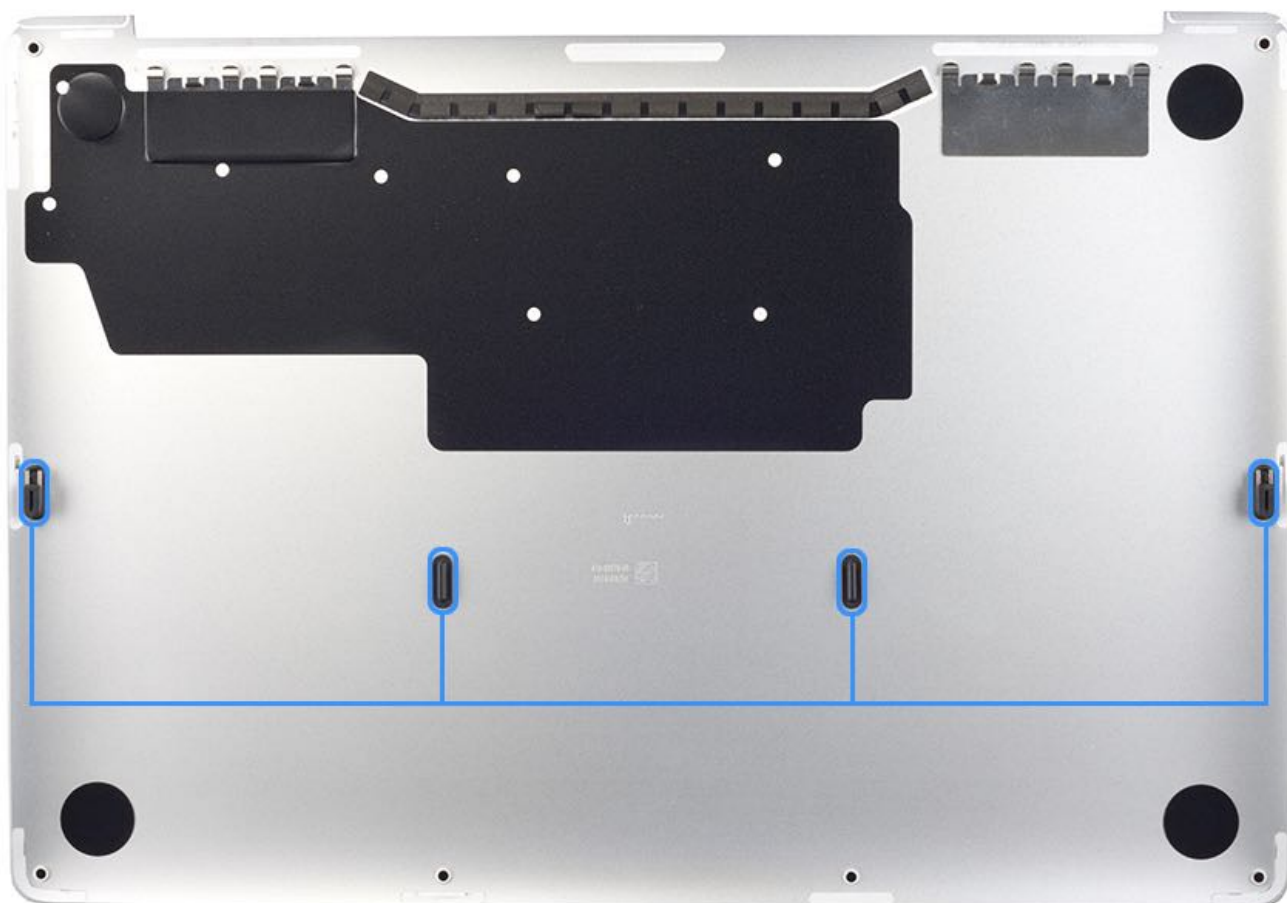
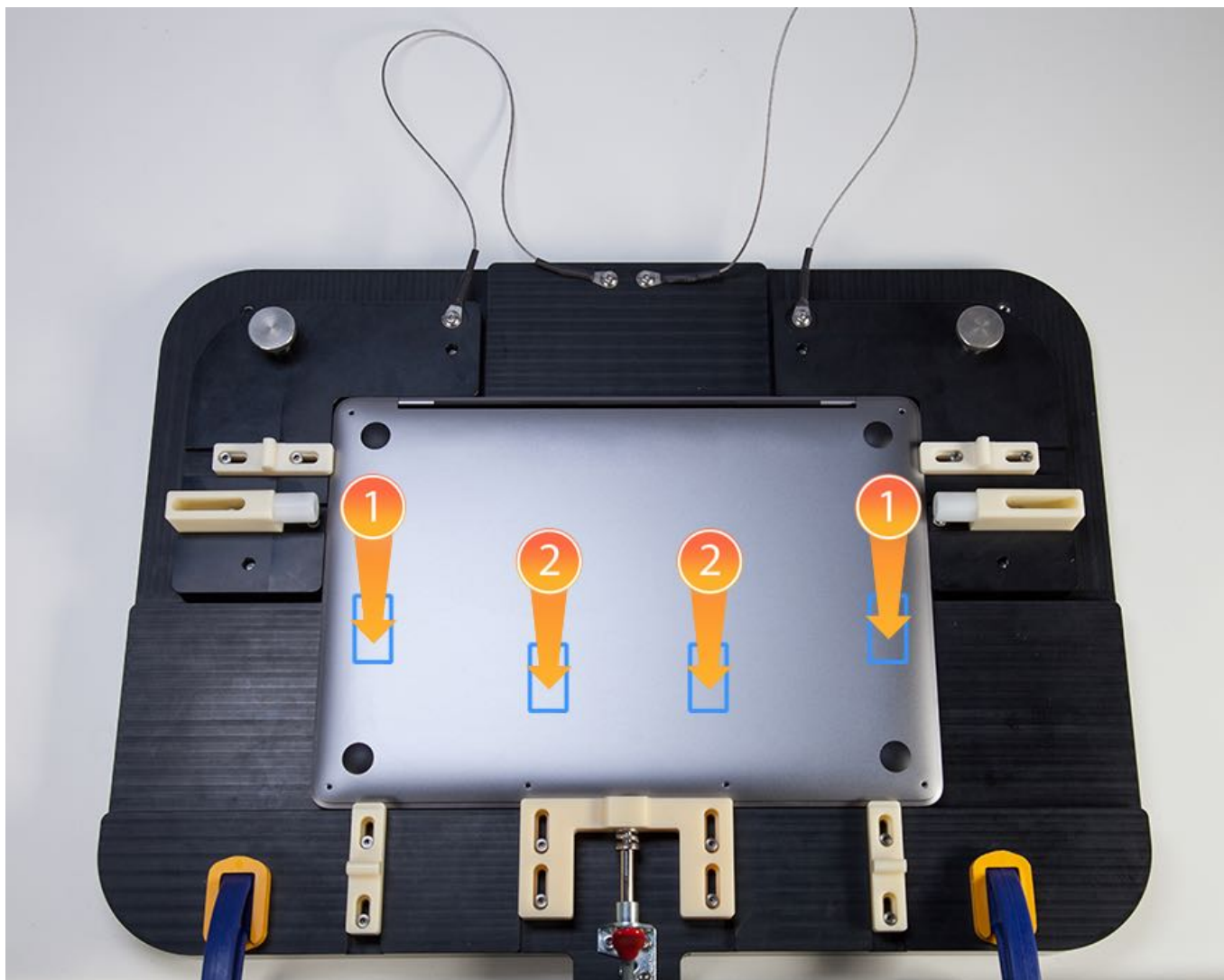


8. As soon as the rear corners of the bottom case meet the top case corners, disengage the lever.

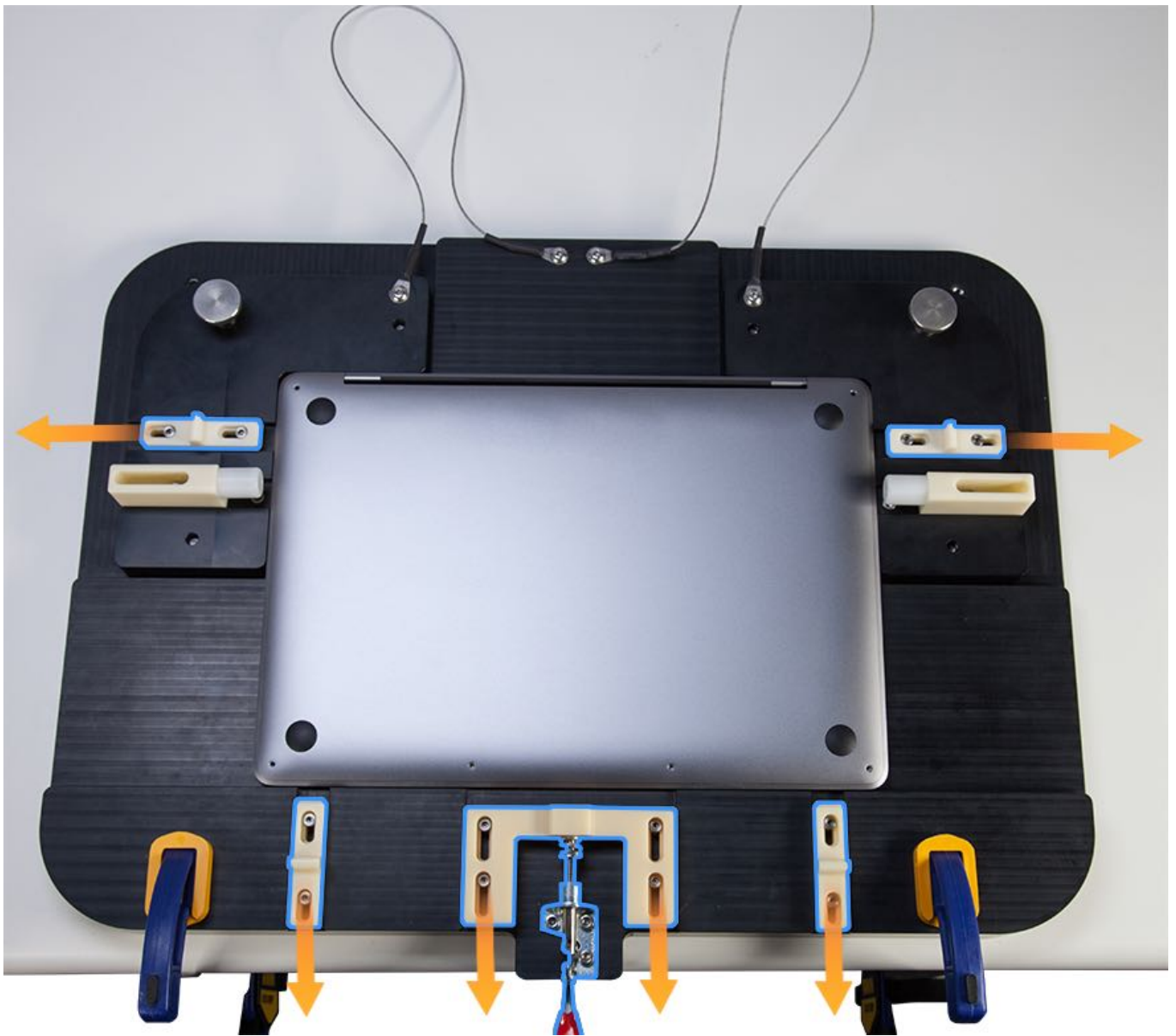
9. If the bottom case is slightly misaligned, use the gripping texture of the gloves to gently apply pressure to adjust the case into alignment. If applying pressure does not realign the bottom case, remove the bottom case and try again.



10. **Important:** First press the sides (1) of the bottom case to snap the two clips in the top case. Then press the middle (2) of the bottom case for the two remaining clips.

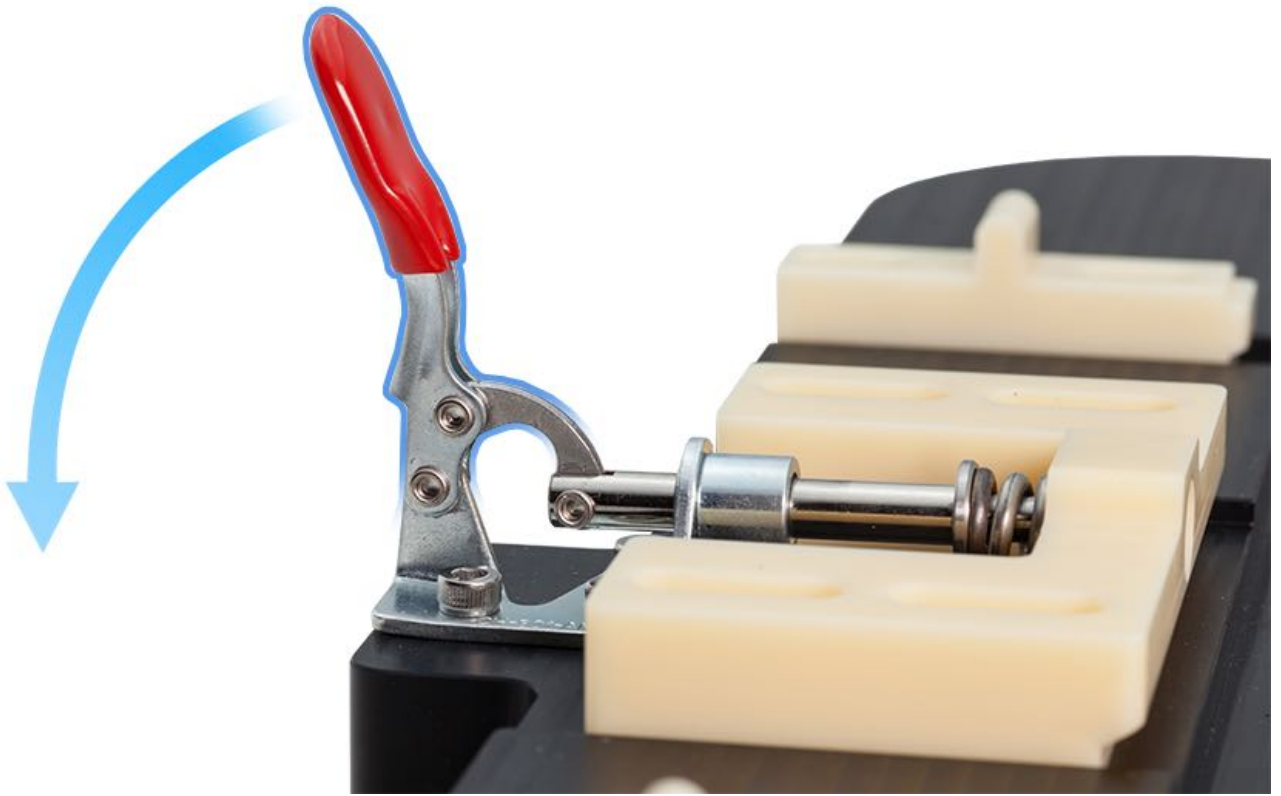


11. Fully disengage the four sliding locks.



12. Remove the computer from the bottom case fixture.

Note: When storing the bottom case fixture, make sure that the red lever is not engaged. Keeping the red lever vertical or fully open protects its inner spring.



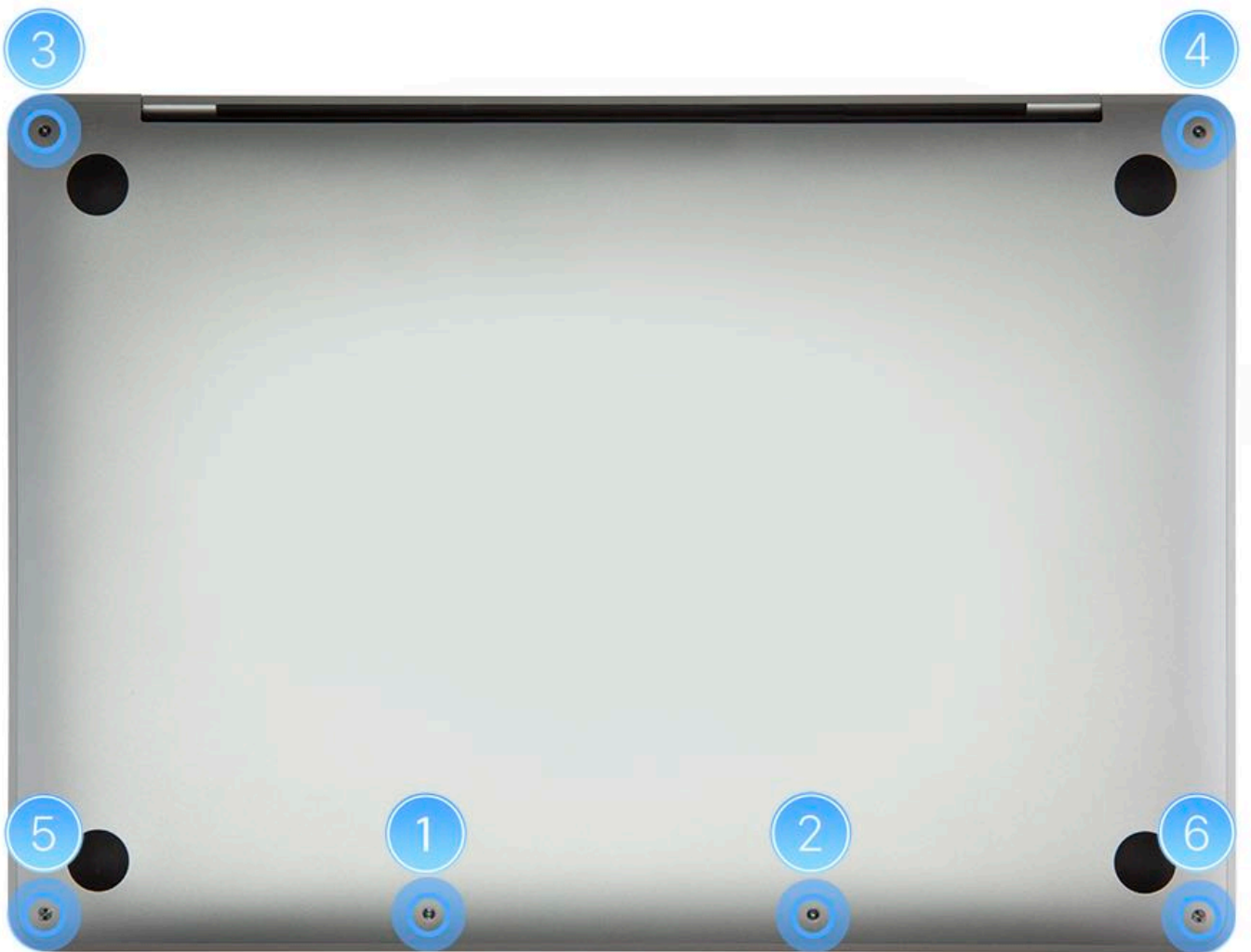
13. Check all sides of the bottom case for proper alignment with the top case.



14. Install the six bottom case screws in the following order and see image below:

- Install the short screws at the middle front (1 and 2).
- Install the longest screws at the rear corners (3 and 4).
- Install the medium-length screws at the front corners (5 and 6).

Note: MacBook Pro (13-inch, 2016, 2017, 2018, 2019, Four Thunderbolt 3 Ports) and MacBook Pro (15-inch, 2016, 2017, 2018, 2019) only have two sizes of screws but the reinstallation order is the same as above.



15. Follow the instructions in [TP1314: Trackpad Calibration Check](#) to verify the trackpad performance after every repair.

Battery Cover and Disconnecting the Battery

First Steps



Warning:

- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

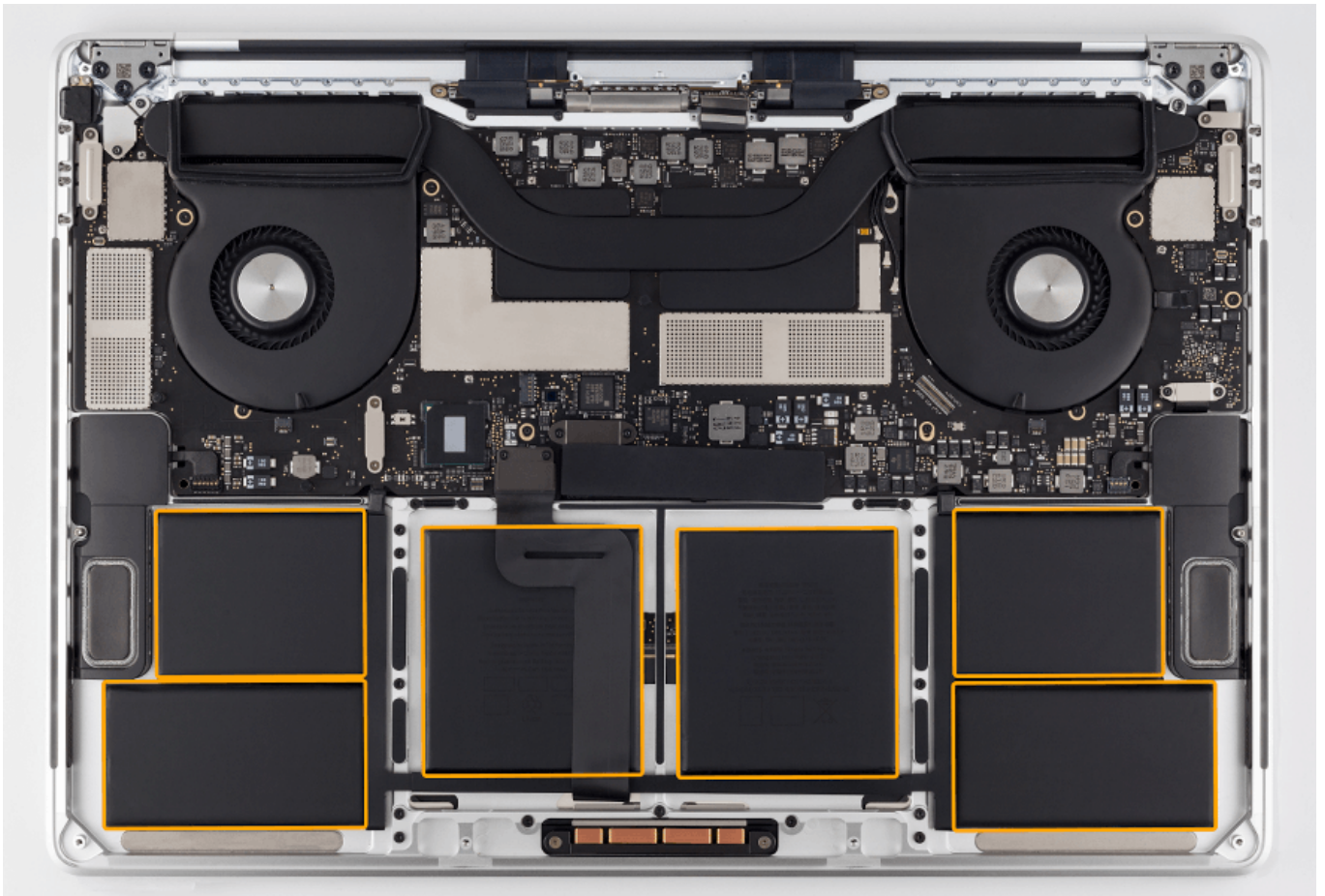
Important:

- Only Apple-certified technicians should perform this procedure. For more information, refer to [OP1859: About Apple service certifications](#).
- Wear an ESD wrist strap and take precautions to avoid ESD.

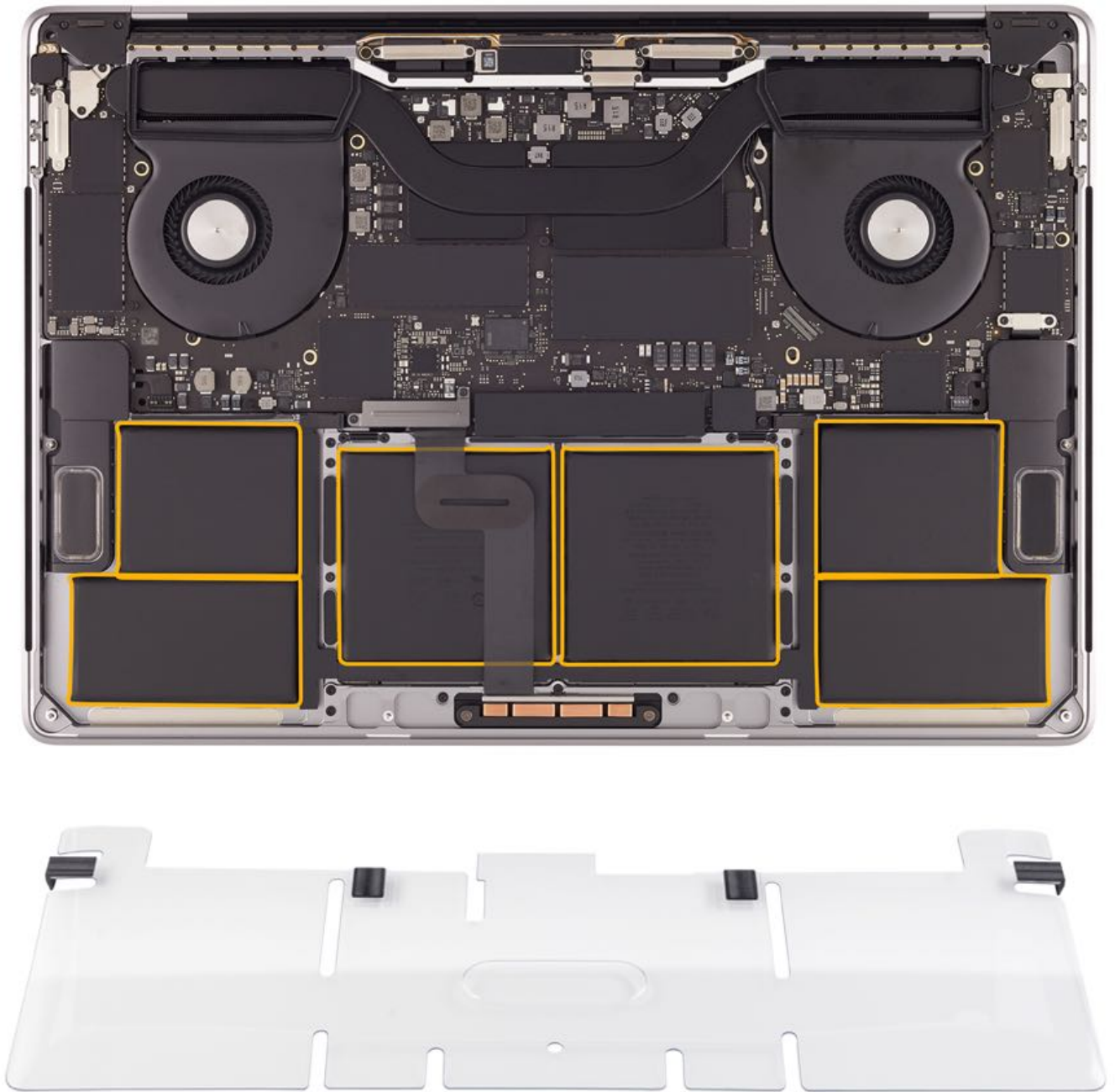
Remove:

- [Bottom case](#)

Battery, MacBook Pro (2016 and 2017):



Battery, MacBook Pro (2018 and 2019):



Tools

- ESD-safe tweezers
- Black stick
- Torx T5 screwdriver
- ESD wrist strap
- Battery cover

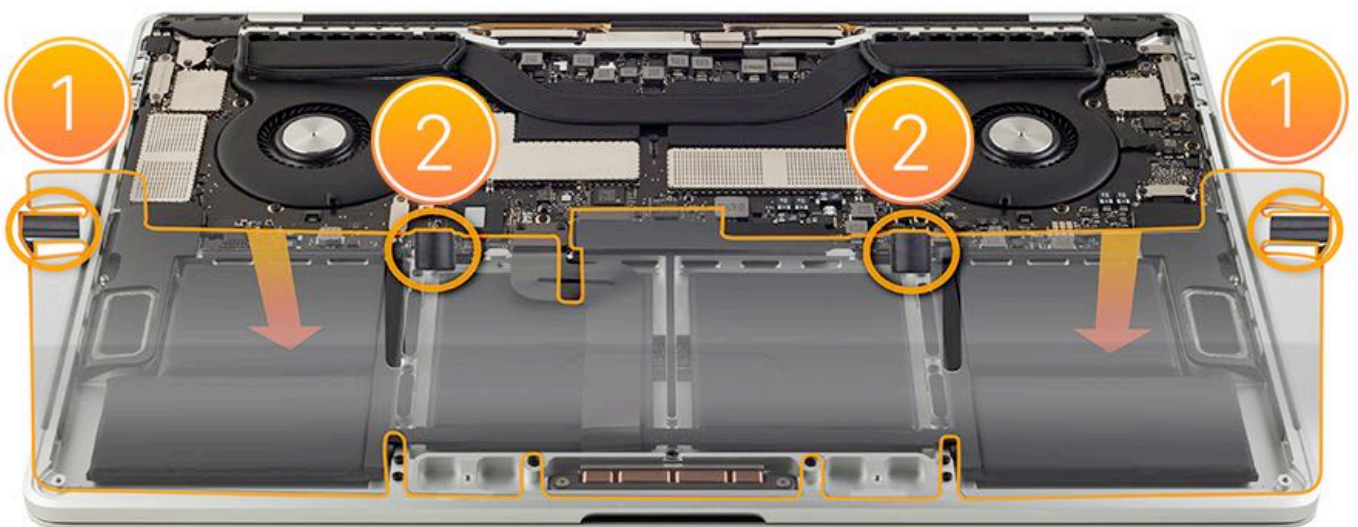


Steps For Removal

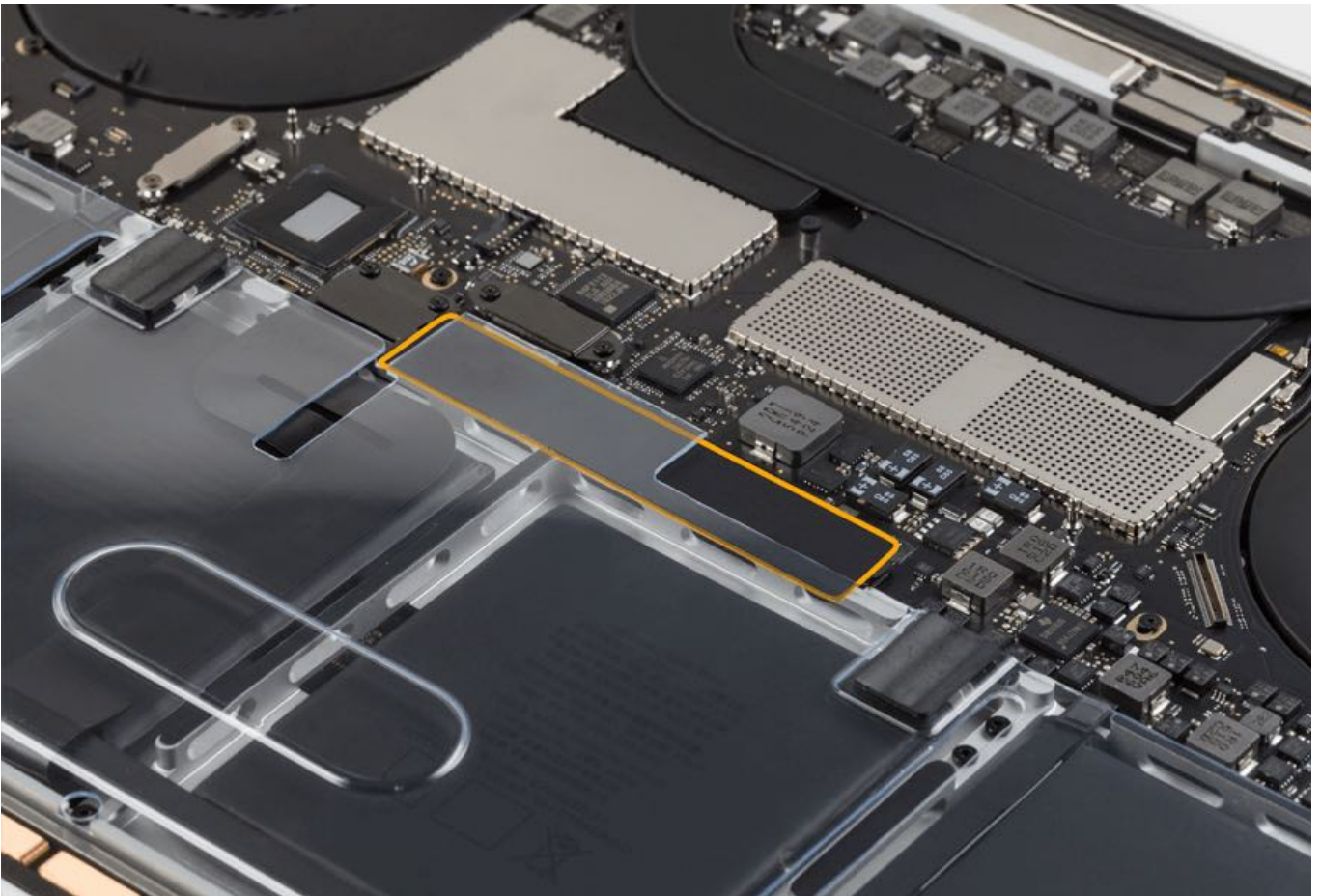
Battery Covers:

- 923-01320 for MacBook Pro (15-inch, 2016 and 2017)
- 923-02532 for MacBook Pro (15-inch, 2018 and 2019)

1. Tilt the bottom tabs of the battery cover into the slots at the bottom edge of the top case.
2. Carefully lower the cover onto the battery cells, making sure the tabs (1) on the sides of the cover fit into the notches on the edges of the top case.
3. Securely attach the battery cover with two clips that snap onto the midwall of the top case (2).



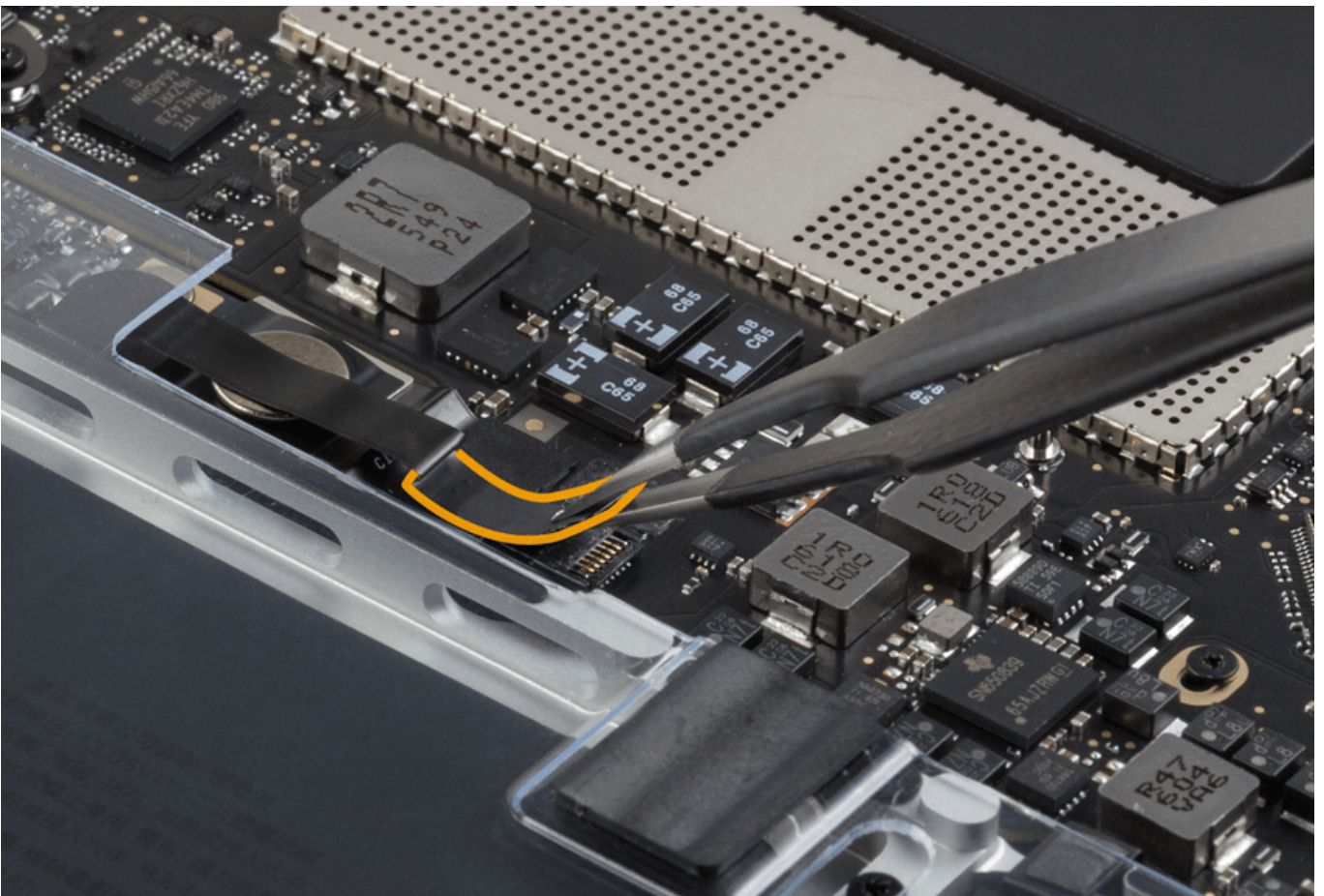
4. Remove the mylar BMU cover and set it aside to be reinstalled.



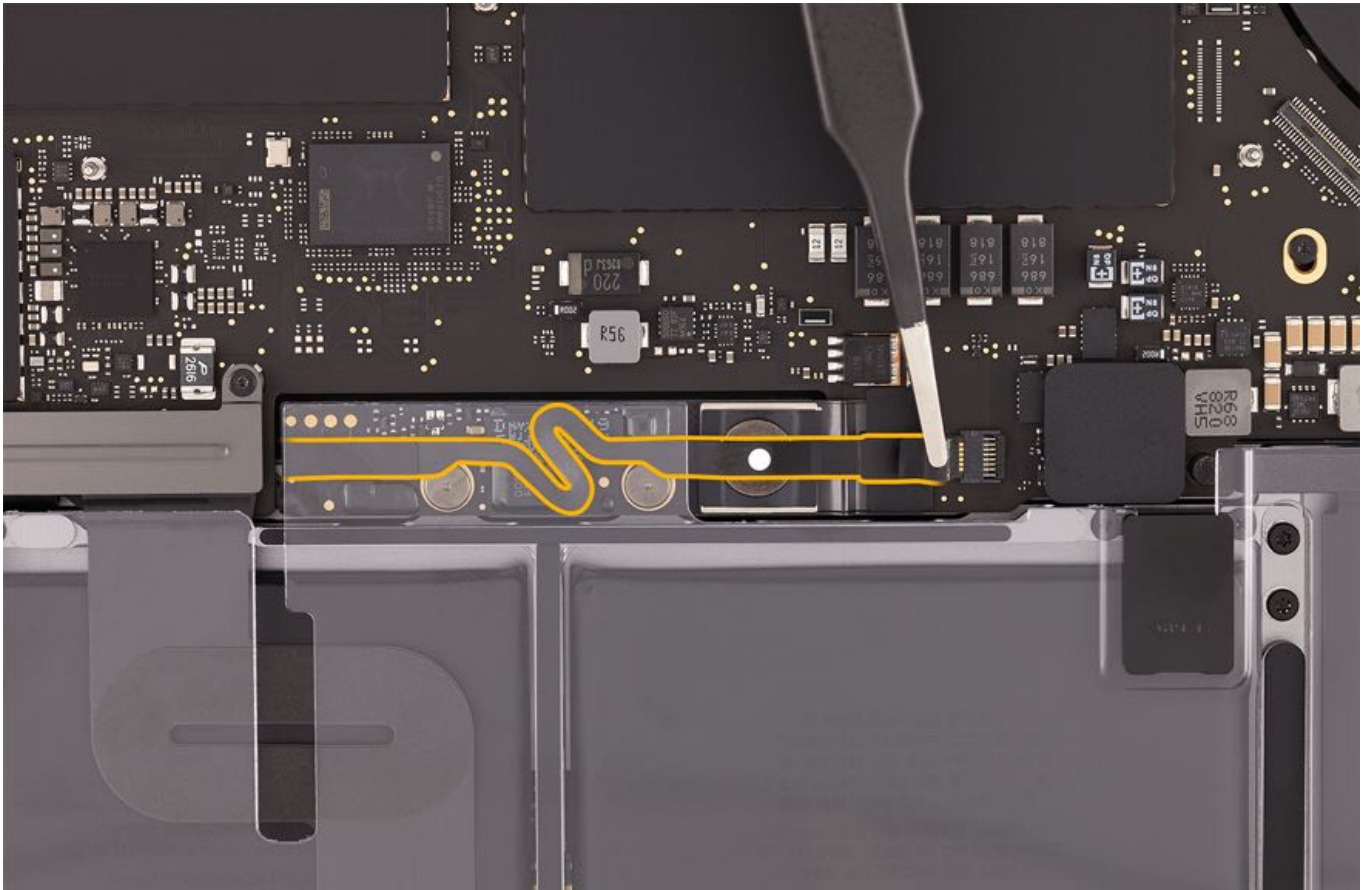
5. Use tweezers to lightly grasp the mylar tab covering the battery flex cable connector and gently peel back the tab to expose the locking lever.

Note: Although the flex cable shape differs between models, the steps are the same.

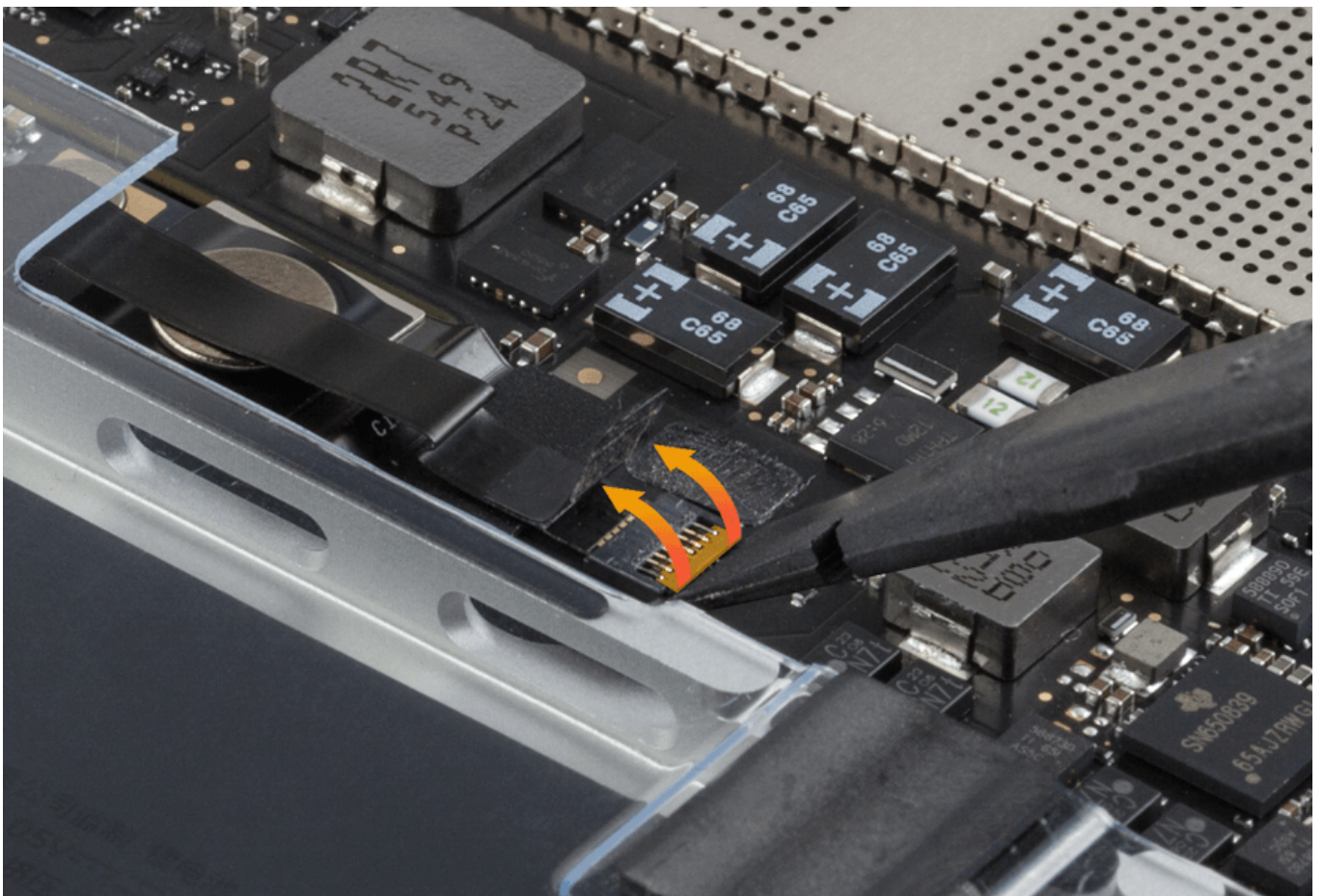
Battery Flex Cable, MacBook Pro (2016 and 2017):



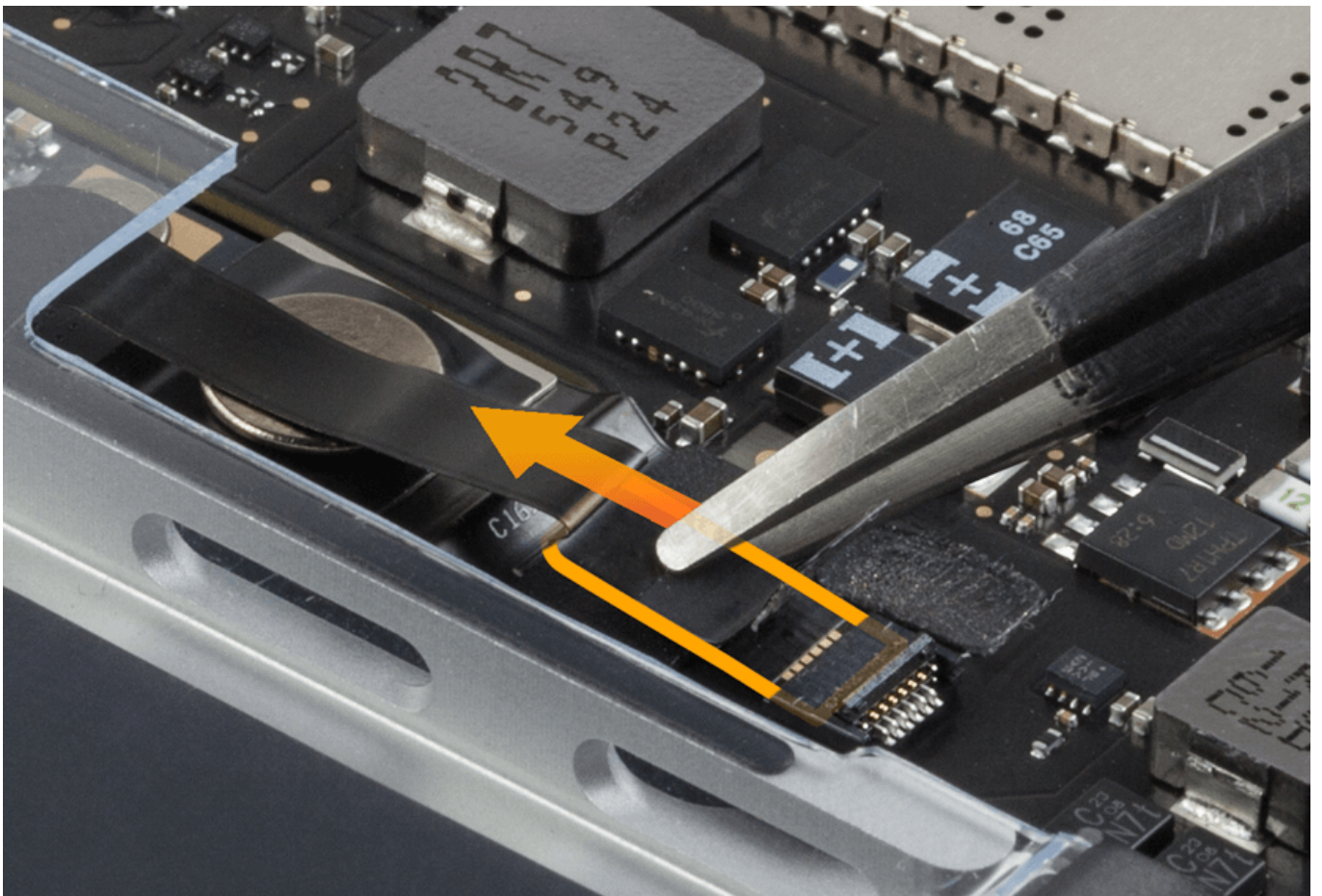
Battery Flex Cable, MacBook Pro (2018 and 2019):



6. Use the flat end of a black stick to flip up the locking lever.



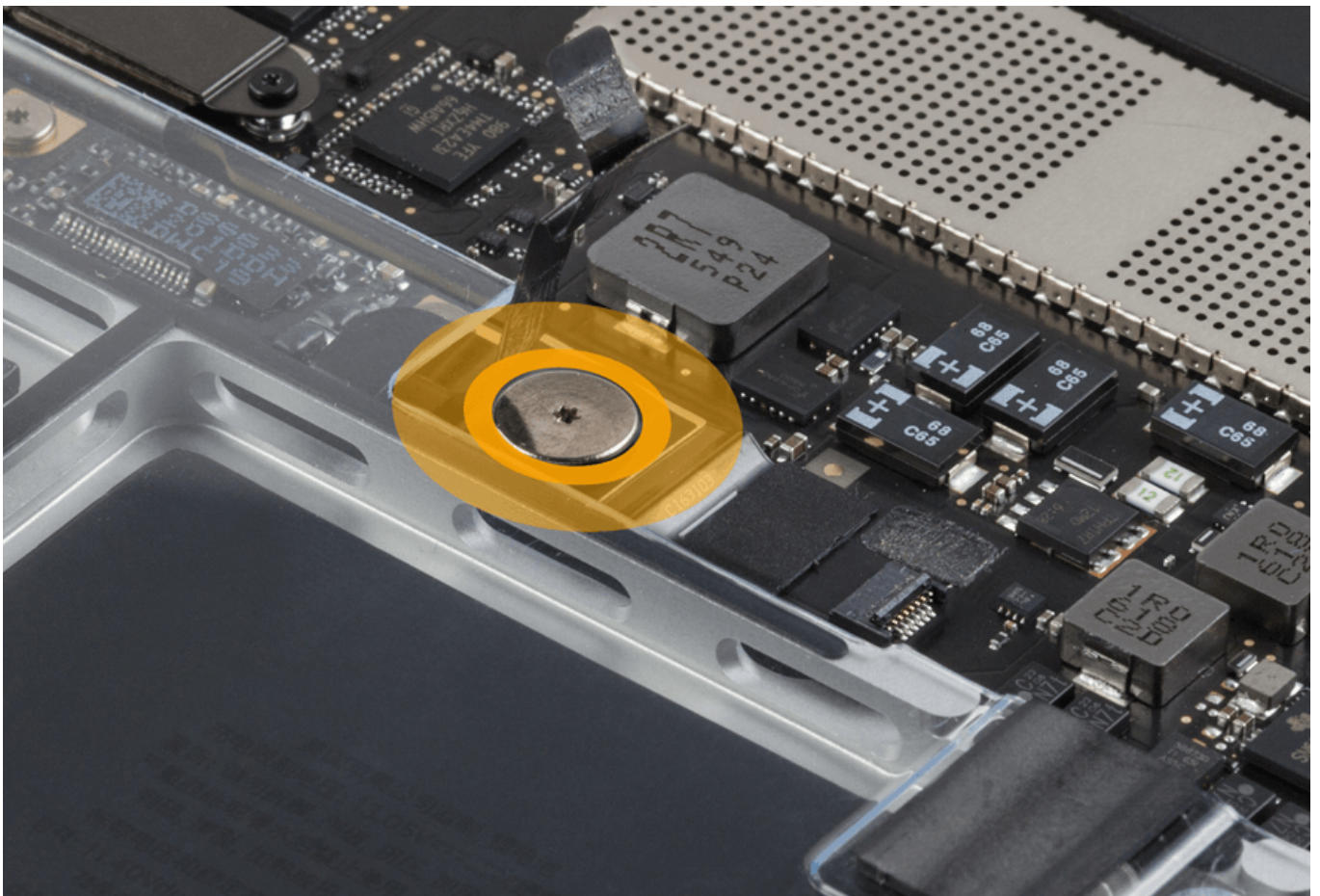
7. Use the flat-nosed tweezers to carefully remove the flex cable from the connector.



8. Remove the Torx T5 BMU screw.



- T5: 923-01418



Steps For Reassembly

Reassemble in reverse order of removal steps.

Notes for reassembly:

- Reinstall the BMU screw, reconnect the battery flex cable, and remove the battery cover.
- Be sure to reinstall the BMU cover.
- Follow the instructions in [TP1314: Trackpad Calibration Check](#) to verify the trackpad performance after every repair.

BMU Flex Cable

First Steps



Warning:

- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

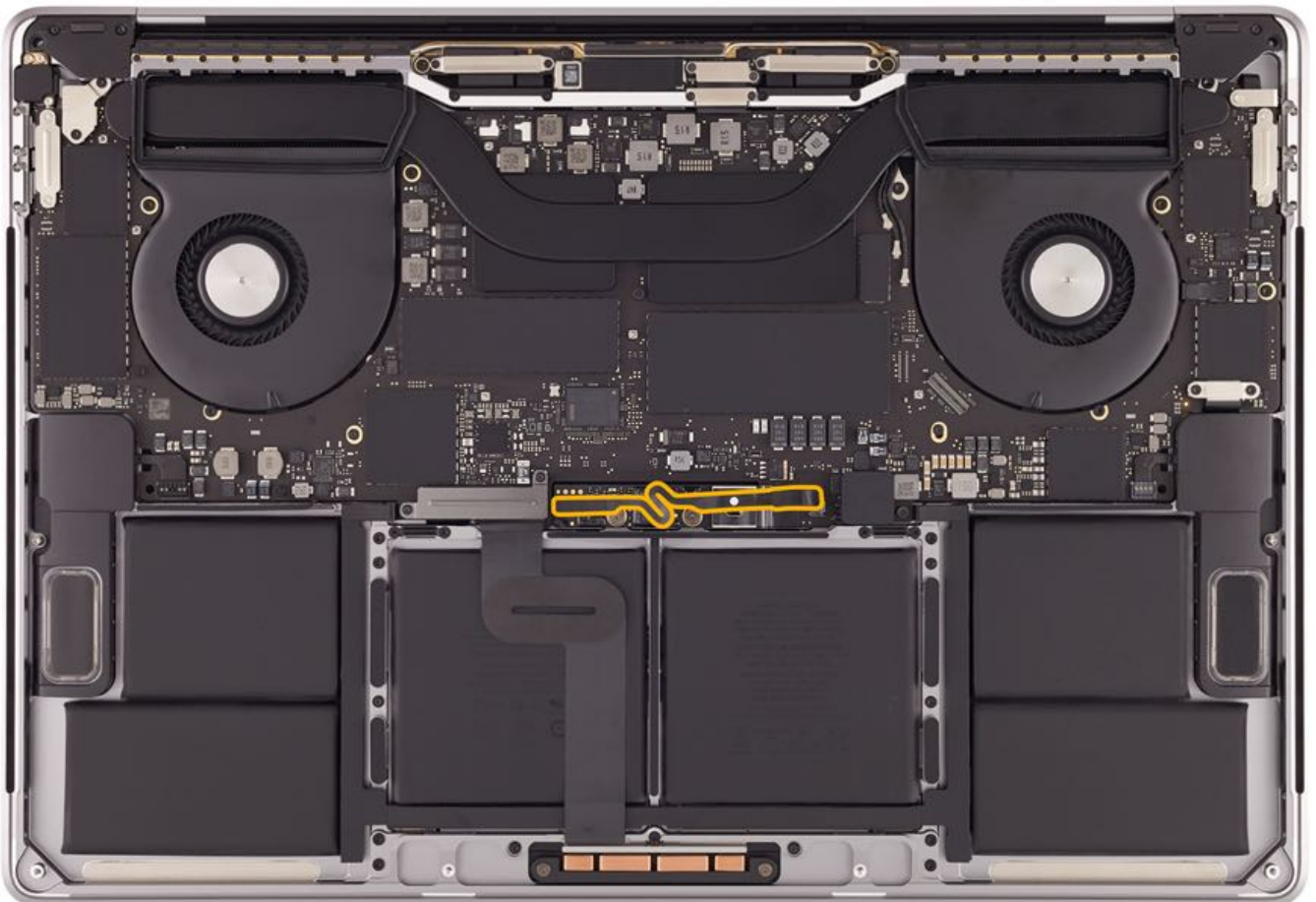
Important:

- Only Apple-certified technicians should perform this procedure. For more information, refer to [OP1859: About Apple service certifications](#).
- Wear an ESD wrist strap and take precautions to avoid ESD.

Remove:

- [Bottom case](#)
- [Attach battery cover and disconnect battery](#)

BMU Flex Cable, MacBook Pro (15-inch, 2018 and 2019):



Tools

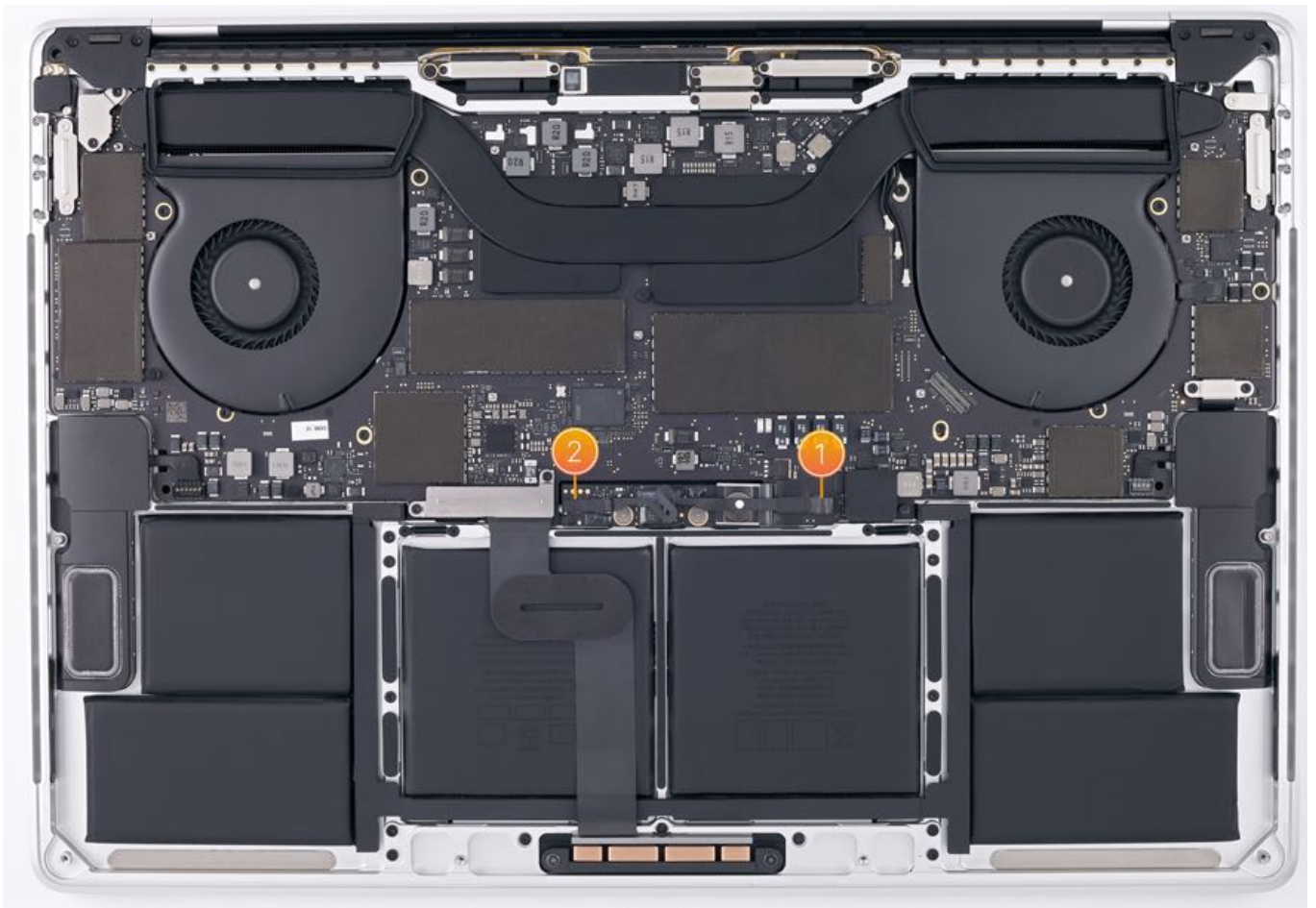
- Black stick



Steps For Removal

Note: Replace the BMU flex cable if it is bent or damaged.

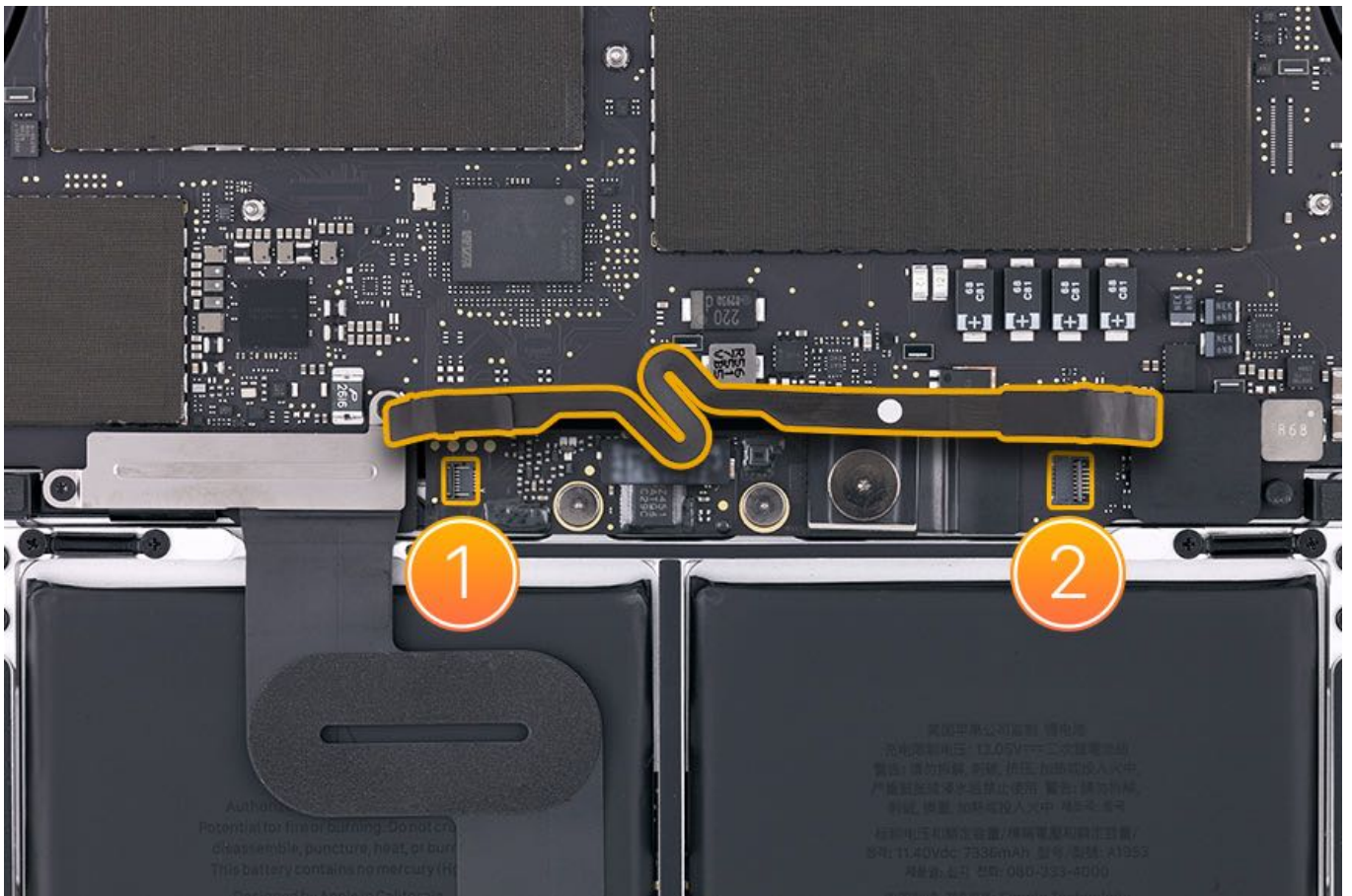
1. Disconnect the BMU flex cable first from the locking lever connector on the logic board (1) and then from the locking lever connector on the BMU board (2).



Steps For Reassembly

Reassemble in reverse order.

1. Insert one end of the BMU flex cable into the locking lever on the BMU board (1) and the other end into the locking lever on the logic board (2). Be sure the flex cable is in the orientation shown below.



2. Reinstall the [bottom case](#).
3. Follow the instructions in [TP1314: Trackpad Calibration Check](#) to verify the trackpad performance after every repair.

Clutch Covers

First Steps



Warning:

- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

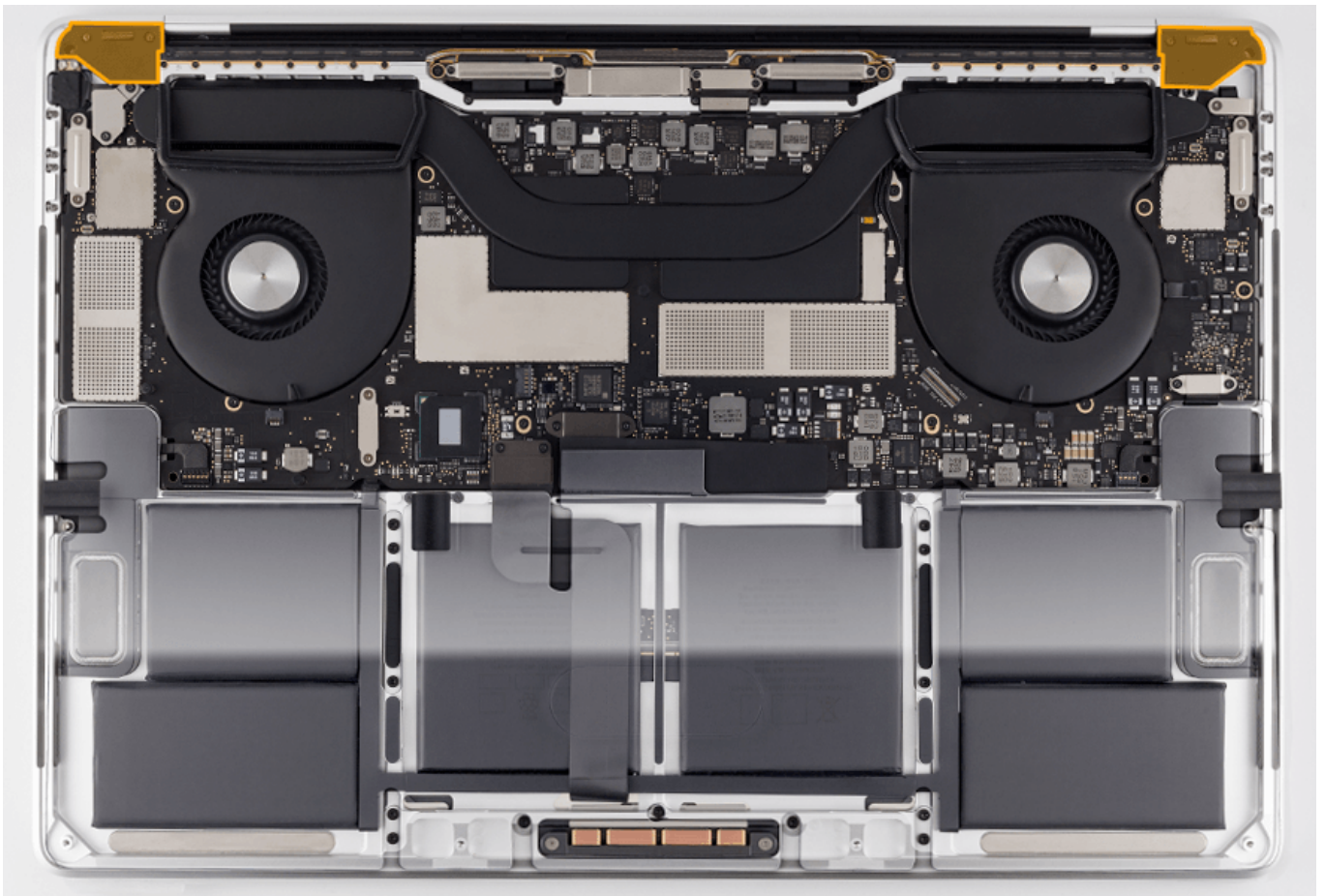
Important:

- Only Apple-certified technicians should perform this procedure. For more information, refer to [OP1859: About Apple service certifications](#).
- Wear an ESD wrist strap and take precautions to avoid ESD.

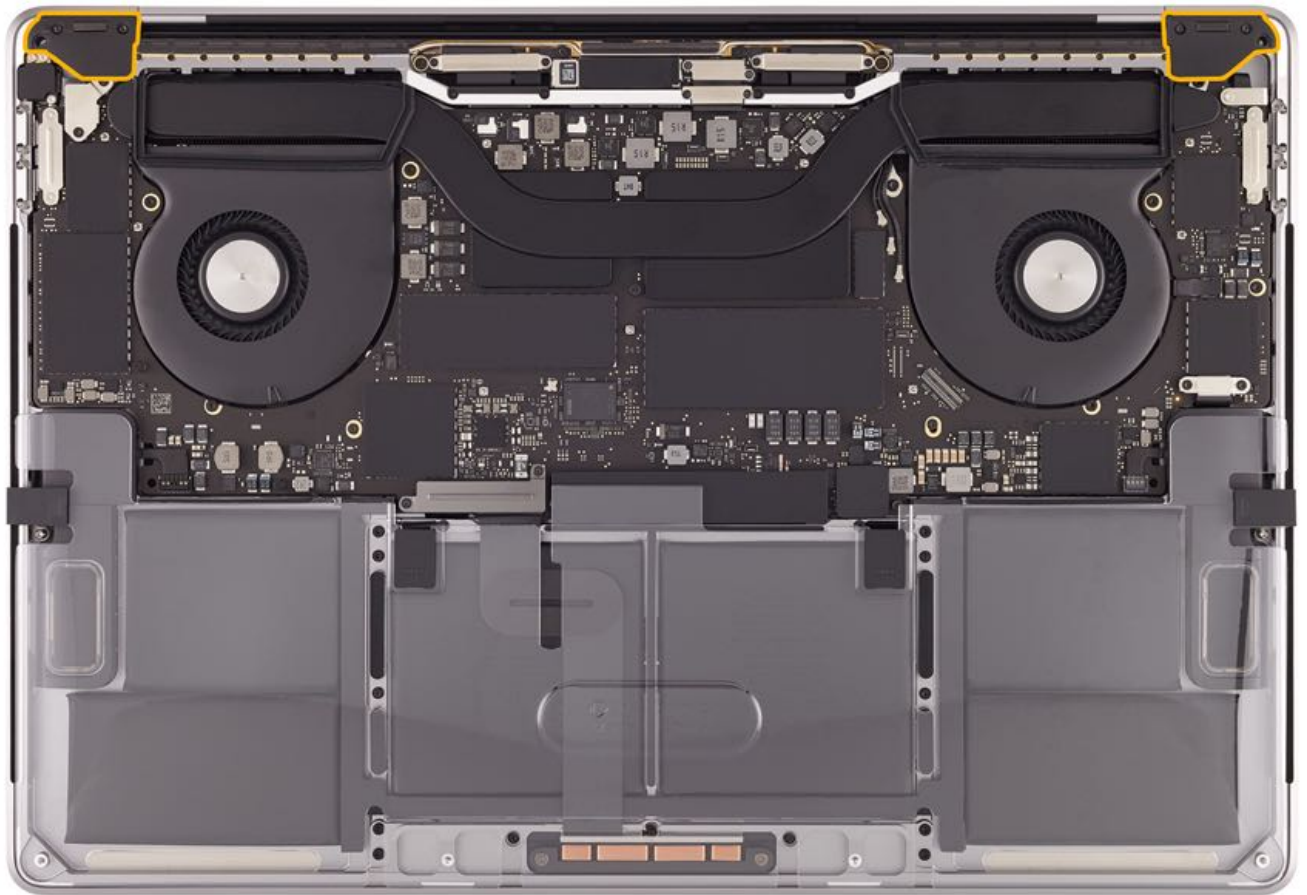
Remove:

- [Bottom case](#)
- [Attach battery cover and disconnect battery](#)

Clutch Covers, MacBook Pro (2017):



Clutch Covers, MacBook Pro (2018 and 2019):



Tools

- Torx T3 screwdriver
- Black stick

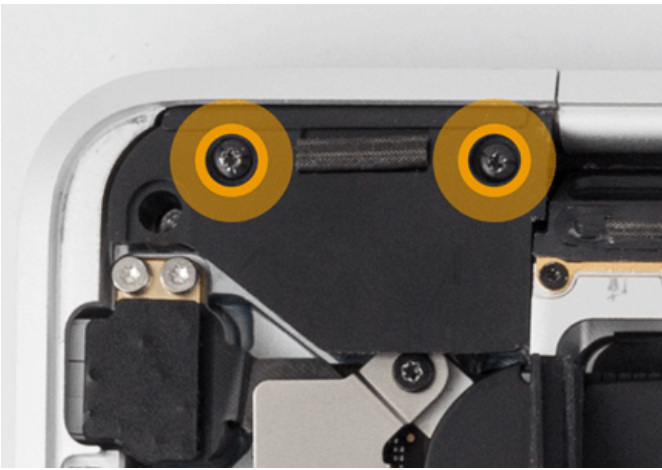


Steps For Removal

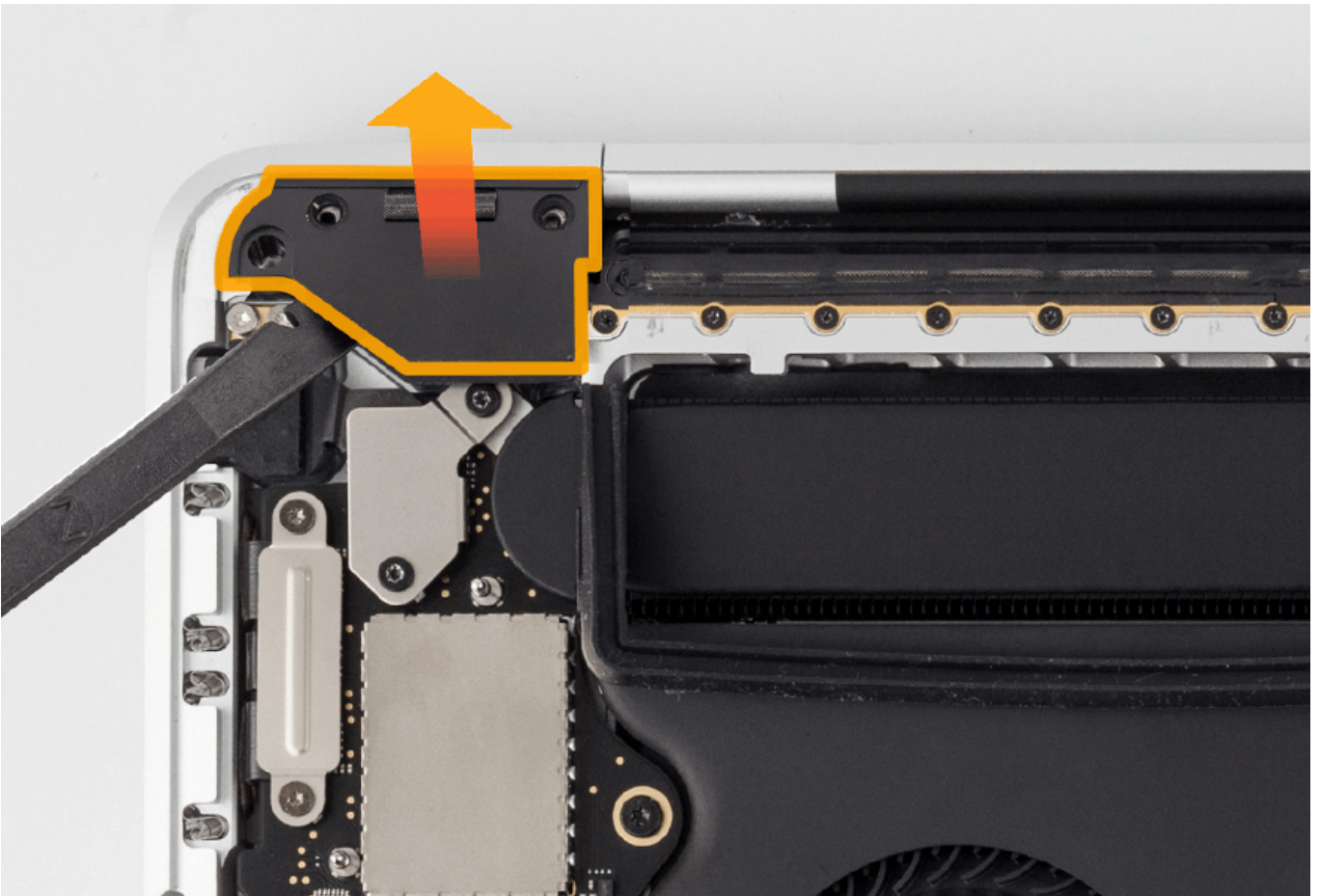
1. Remove two T3 screws from both the left and the right clutch covers.

- Two T3: 923-01286





2. Use a black stick to lift up each clutch cover and remove it from the top case.



Steps For Reassembly

1. Reassemble in reverse order of removal steps.
Note: Reinstall each clutch cover so the top edge of the clutch cover seats under the top edge of the top case.
2. Reinstall the [BMU screw](#), [reconnect the battery](#), and [remove the battery cover](#).
3. Reinstall the [bottom case](#).
4. Follow the instructions in [TP1314: Trackpad Calibration Check](#) to verify the trackpad performance after every repair.

Audio Board

First Steps



Warning:

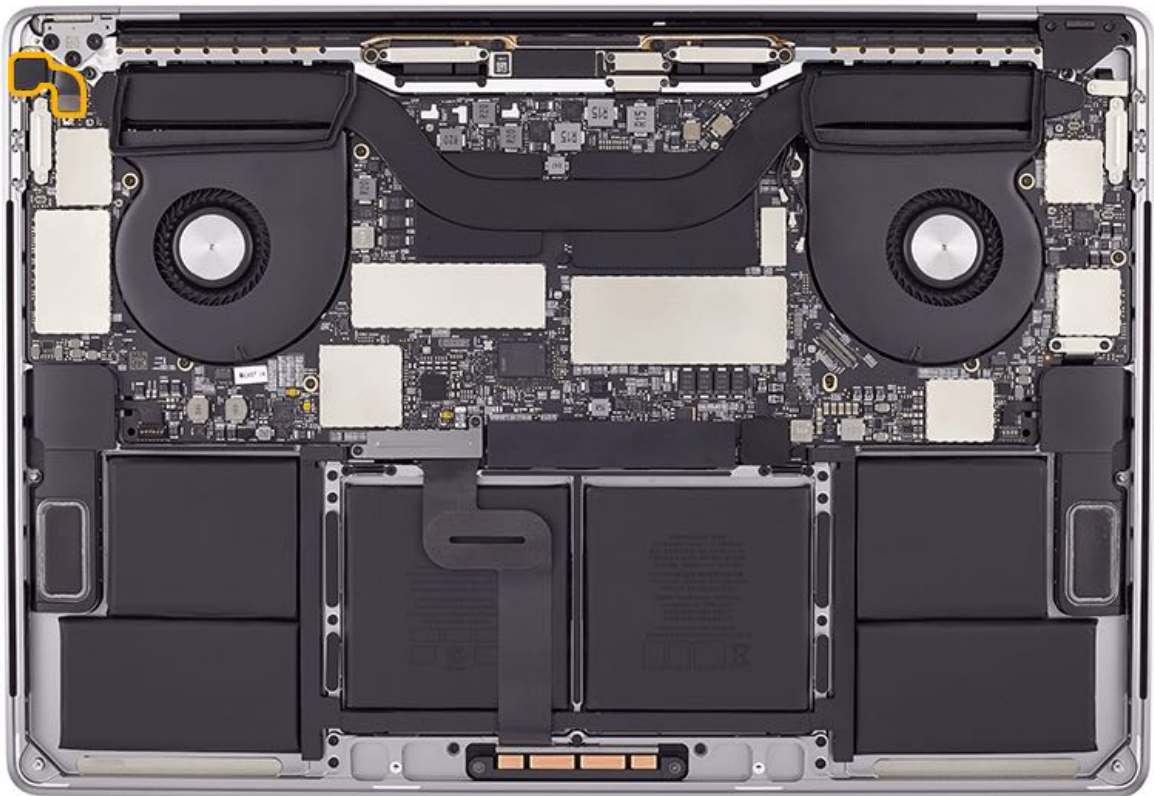
- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

Important:

- Only Apple-certified technicians should perform this procedure. For more information, refer to [OP1859: About Apple service certifications](#).
- Wear an ESD wrist strap and take precautions to avoid ESD.

Remove:

- [Bottom case](#)
- [Attach battery cover and disconnect battery](#)
- [Clutch cover](#) (left only)



Tools

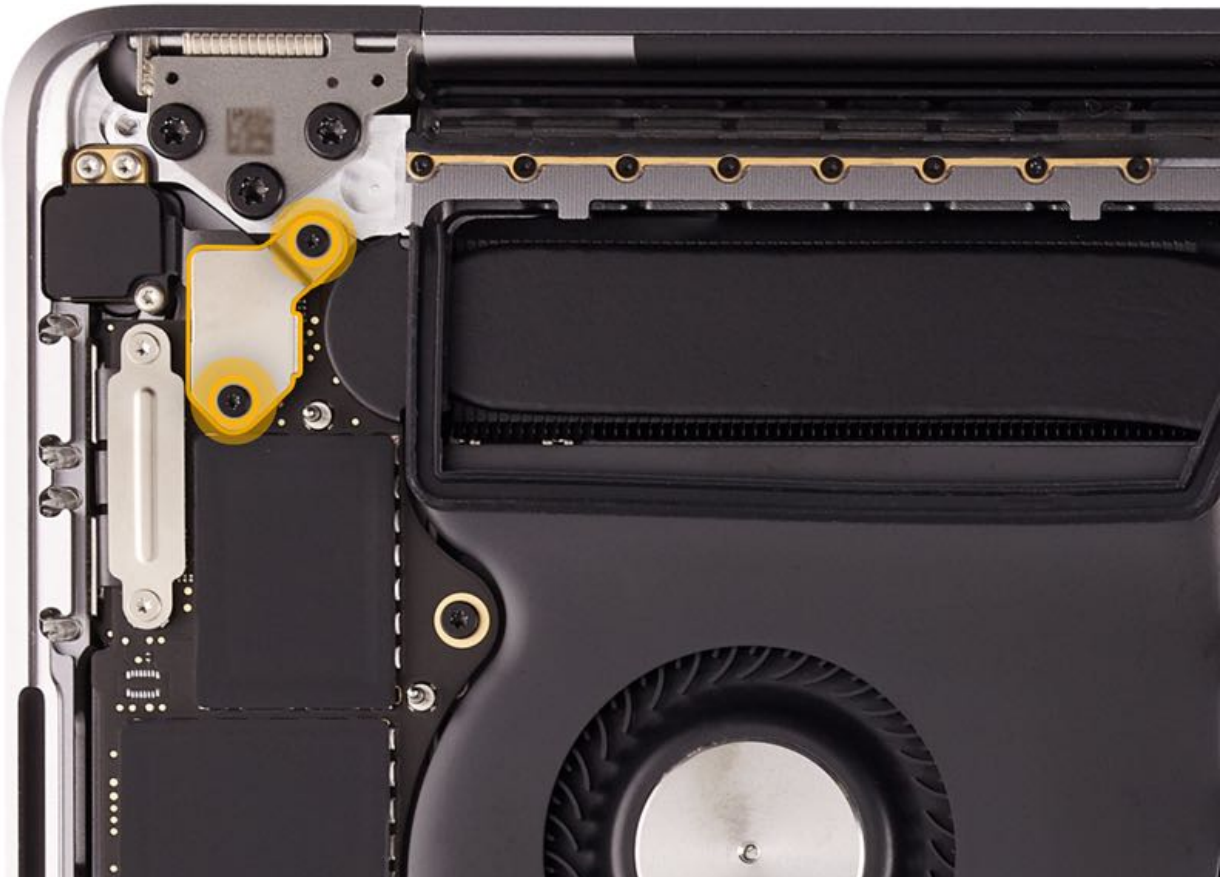
- Torx T3 screwdriver (magnetized)
- Black stick



Steps For Removal

1. Remove the two T3 screws from the Touch ID board cowling. Remove the cowling.

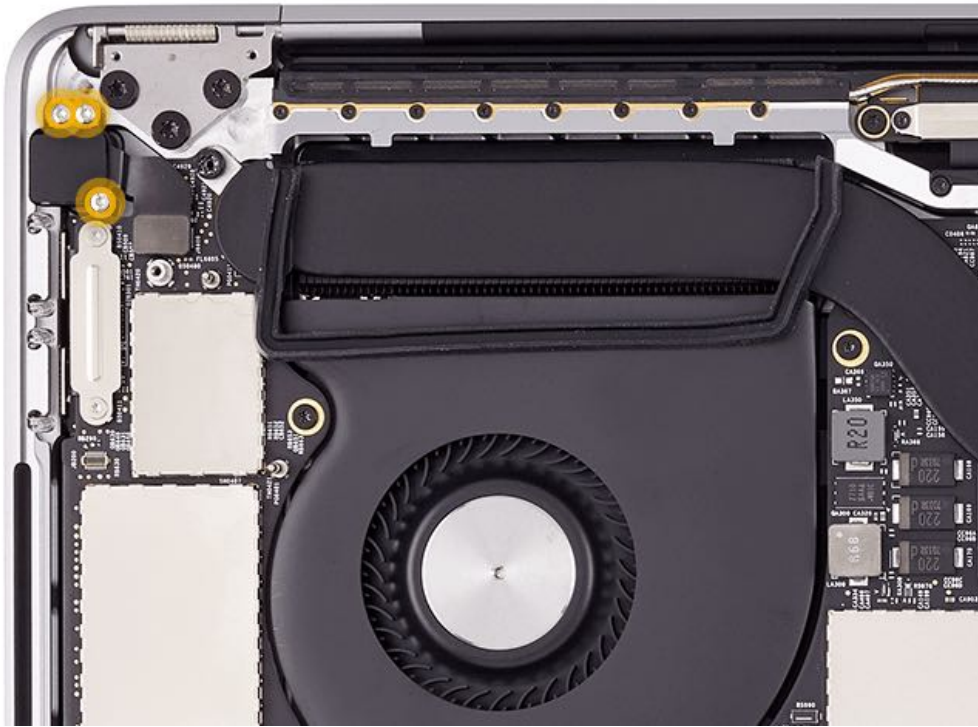
- T3: 923-01506



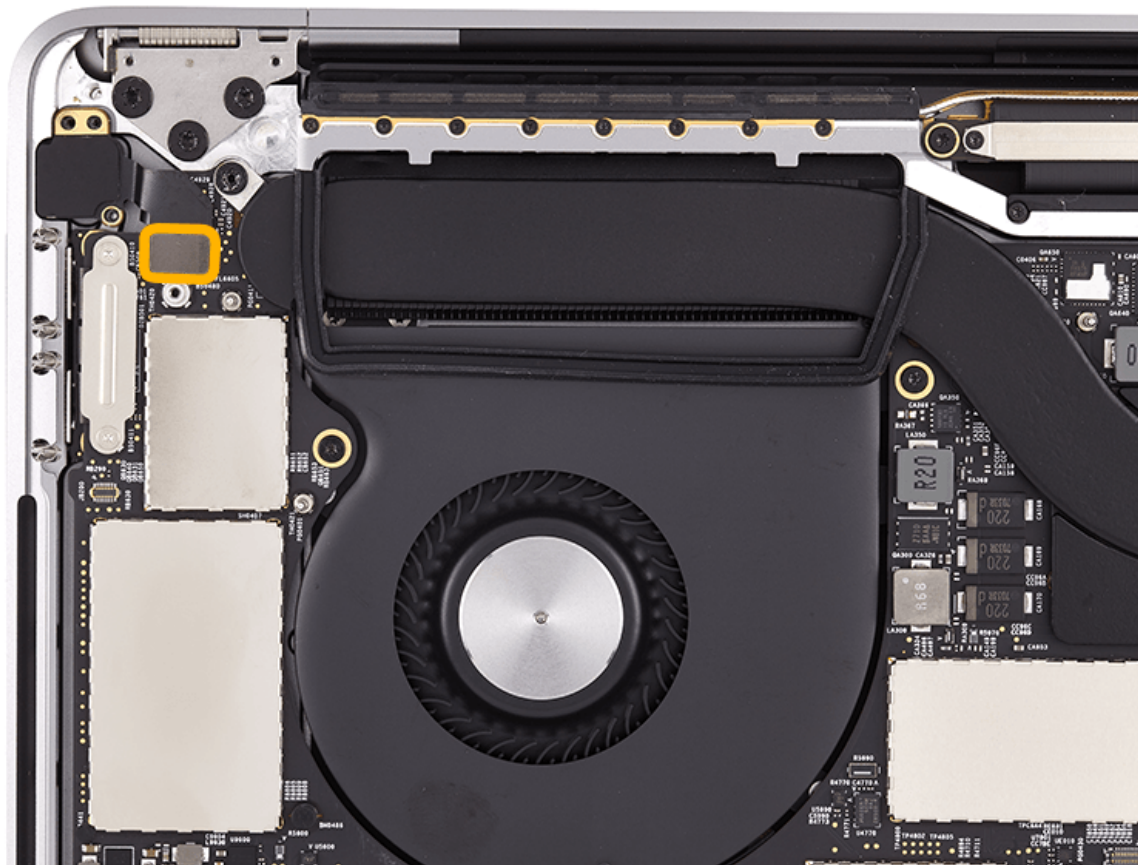
2. Remove the three T3 screws from the audio board.

- T3: 923-02530 (washer included)

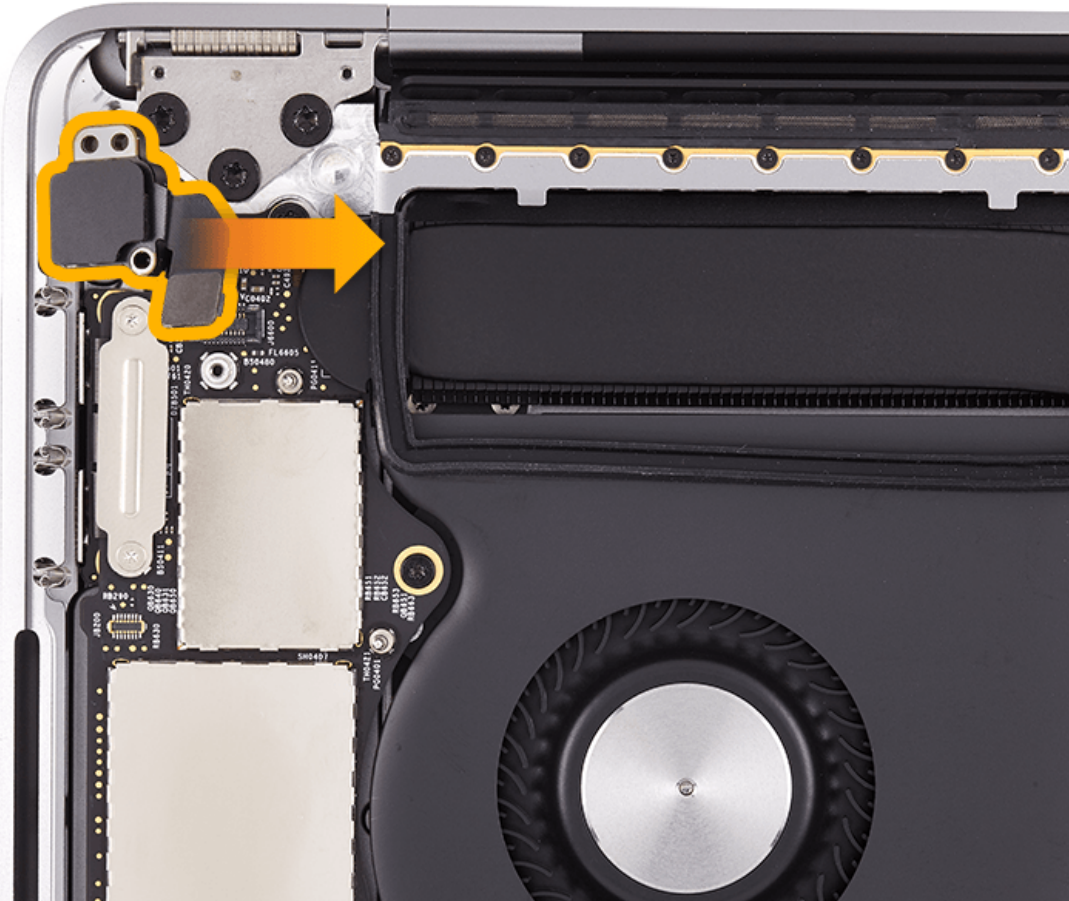




3. Disconnect the audio board flex cable from the logic board.



4. Gently grasp the edges of the audio board flex cable and remove the board from the top case.
Note: Do not pinch or put pressure on the flex cable.

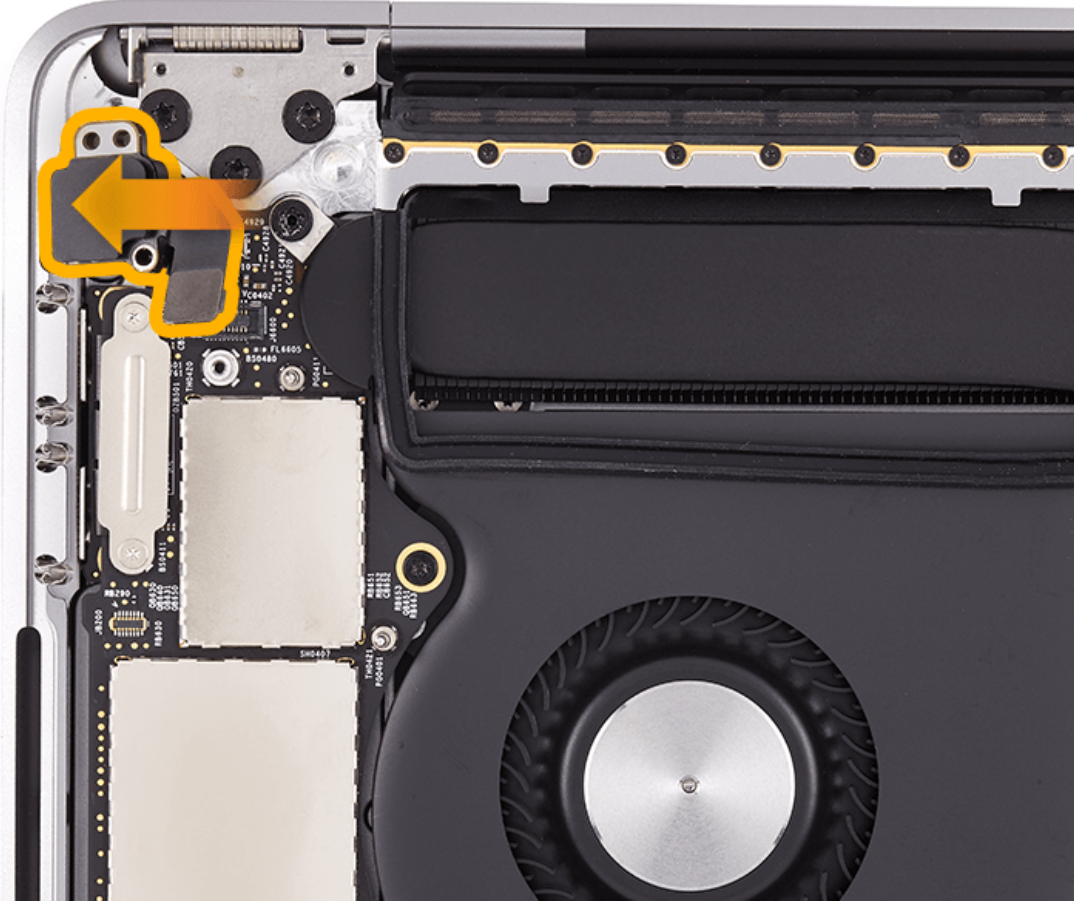


Steps For Reassembly

Note: Be sure to order the correct part when replacing the audio board.

- Space Gray: 923-02495
- Silver: 923-02496

1. Reinstall the audio board.

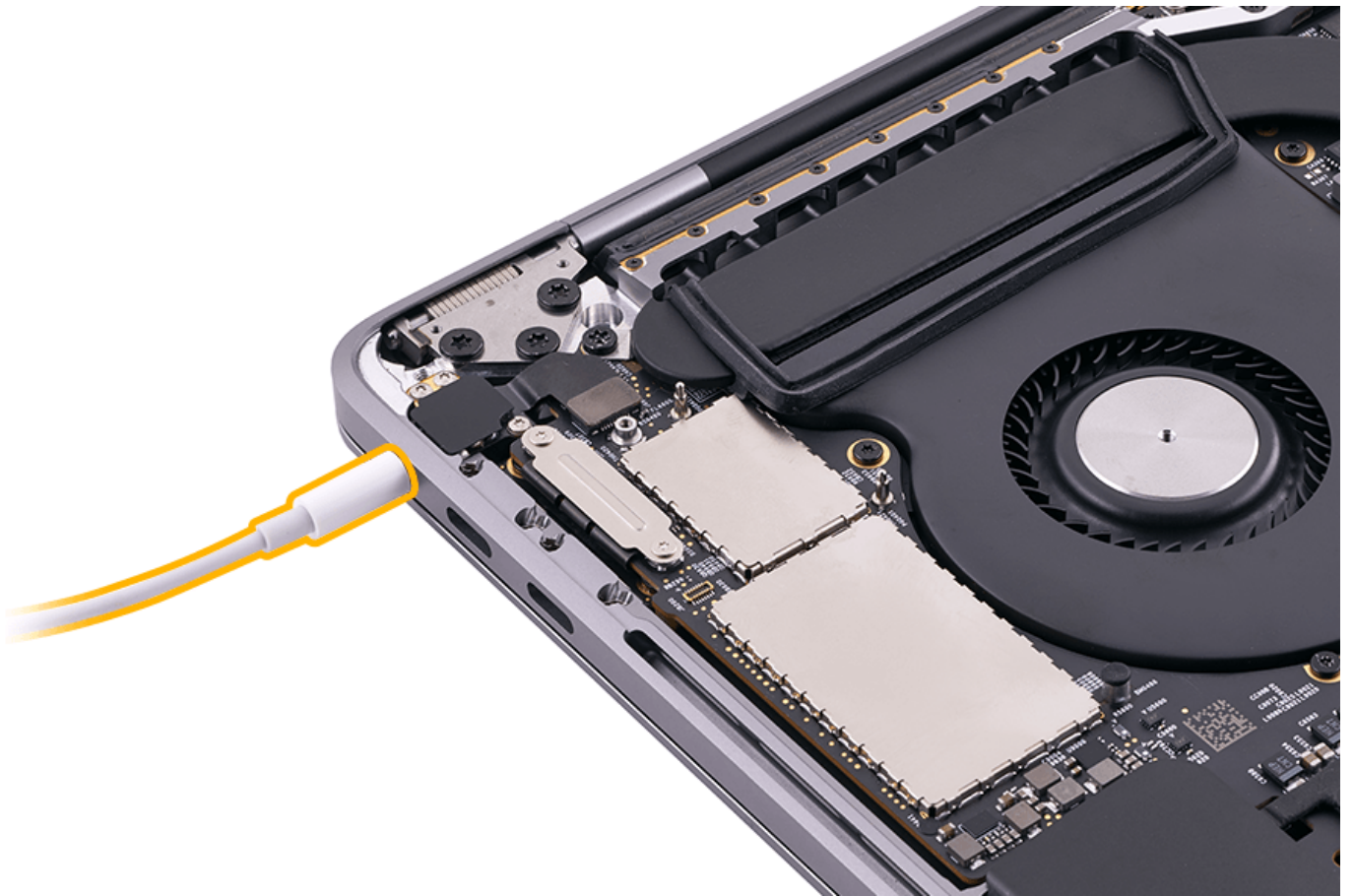


2. Partially reinstall the three T3 screws to keep the audio board in place.

- T3: 923-02530 (washer included)



3. Plug in earphones with a 3.5 mm jack to check alignment. Once the audio board is properly aligned, fully tighten the audio board screws.



4. Reconnect the audio board flex cable.

5. Reinstall the Touch ID board cowling and the two T3 screws.

- T3: 923-01506



6. Reinstall the [clutch covers](#).

7. Reinstall the [BMU screw, reconnect the battery, and remove the battery cover](#).

8. Reinstall the [bottom case](#).

9. Follow the instructions in [TP1314: Trackpad Calibration Check](#) to verify the trackpad performance after every repair.

Logic Board

First Steps



Warning:

- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

Important:

- Only Apple-certified technicians should perform this procedure. For more information, refer to [OP1859: About Apple service certifications](#).
- Wear an ESD wrist strap and take precautions to avoid ESD.

Caution:

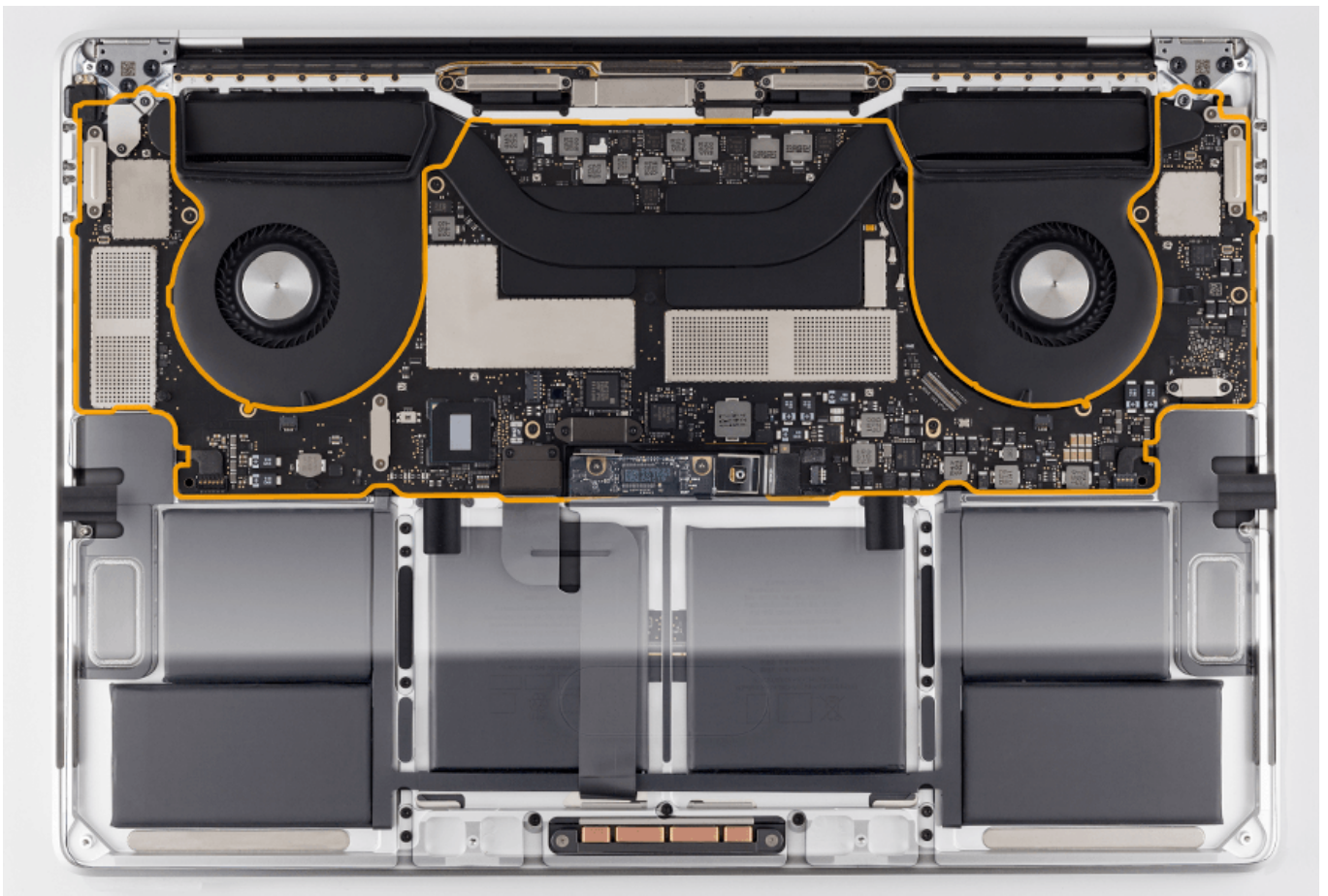
- For MacBook Pro (2018 and 2019), this repair is not complete until System Configuration has been performed. For instructions, refer to [TP1657: System Configuration for Macs with the Apple T2 Security Chip](#).

Remove:

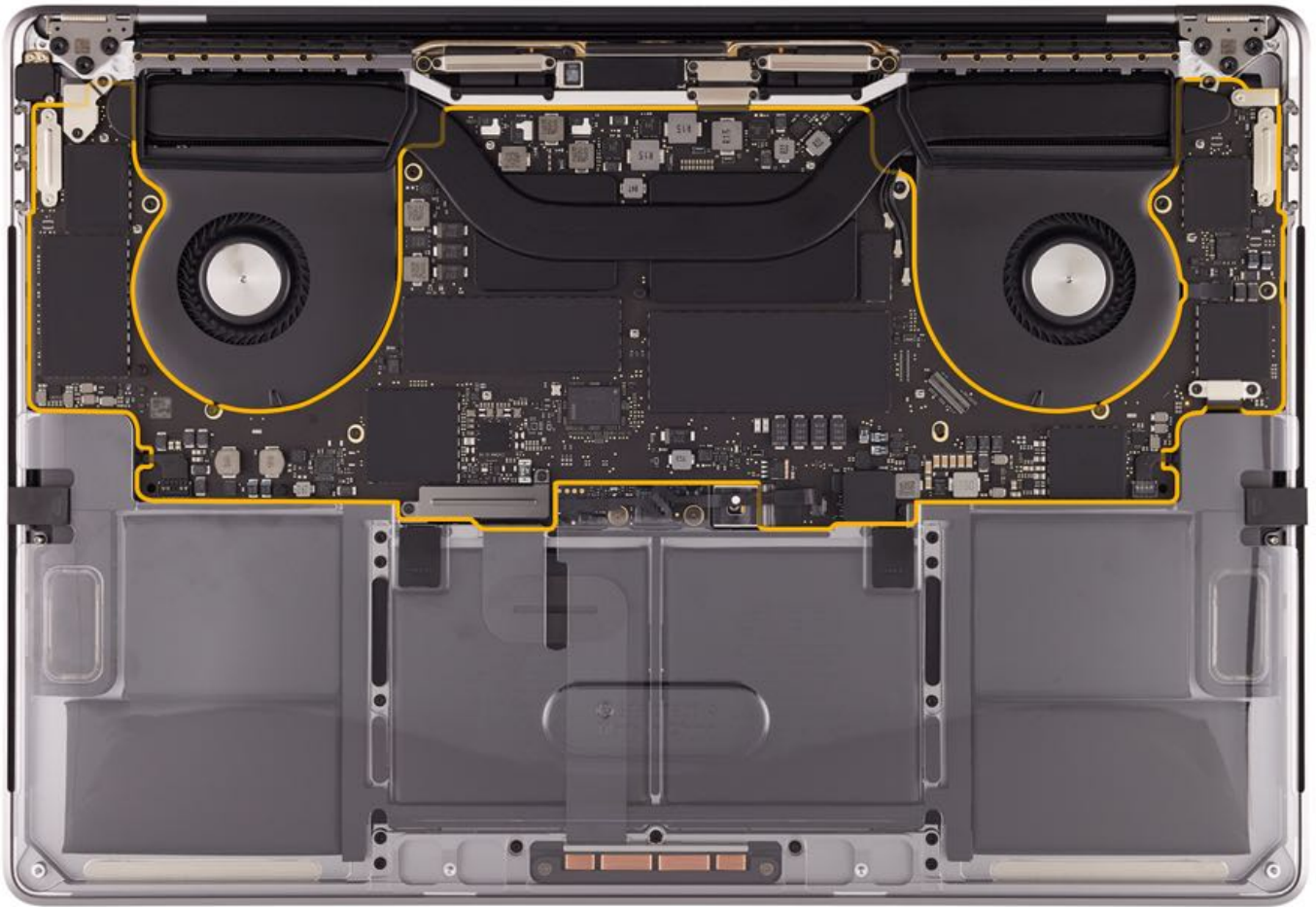
- [Bottom case](#)
- [Attach battery cover and disconnect battery](#)
- [Clutch covers](#)

For video instruction, refer to [SV331: Logic Board Replacement Video](#).

Logic Board, MacBook Pro (15-inch, 2016 and 2017):



Logic Board, MacBook Pro (15-inch, 2018 and 2019):



Tools

- Antenna removal tool
- Black stick
- Torx T3 screwdriver
- Torx T5 screwdriver
- Torx T8 screwdriver
- Phillips #00 (stiffener removal and replacement only)



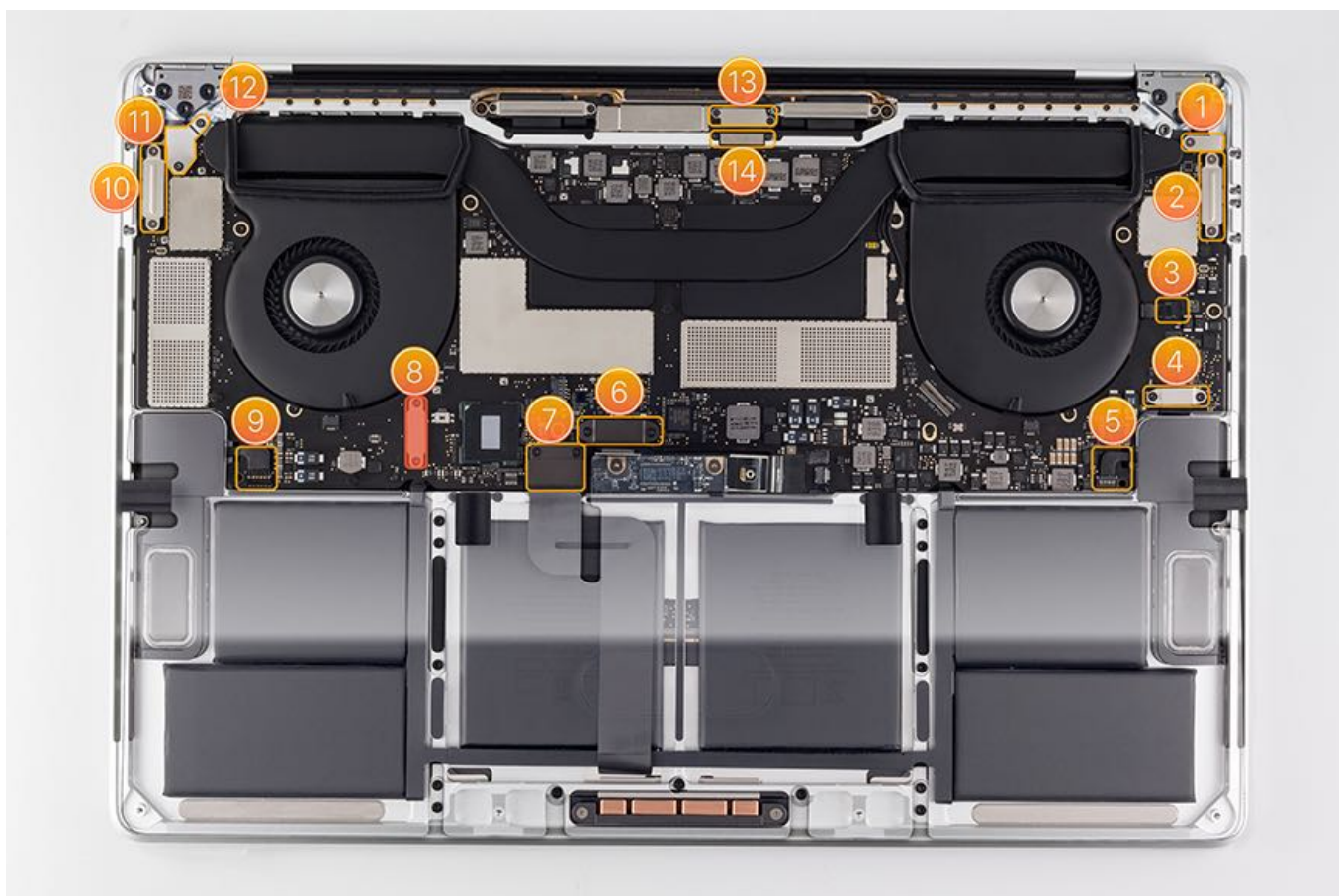
Steps For Removal

1. Some of the logic board connectors differ between models. Compare the computer that you are servicing to the two models shown below and the connector locations listed in this chart.

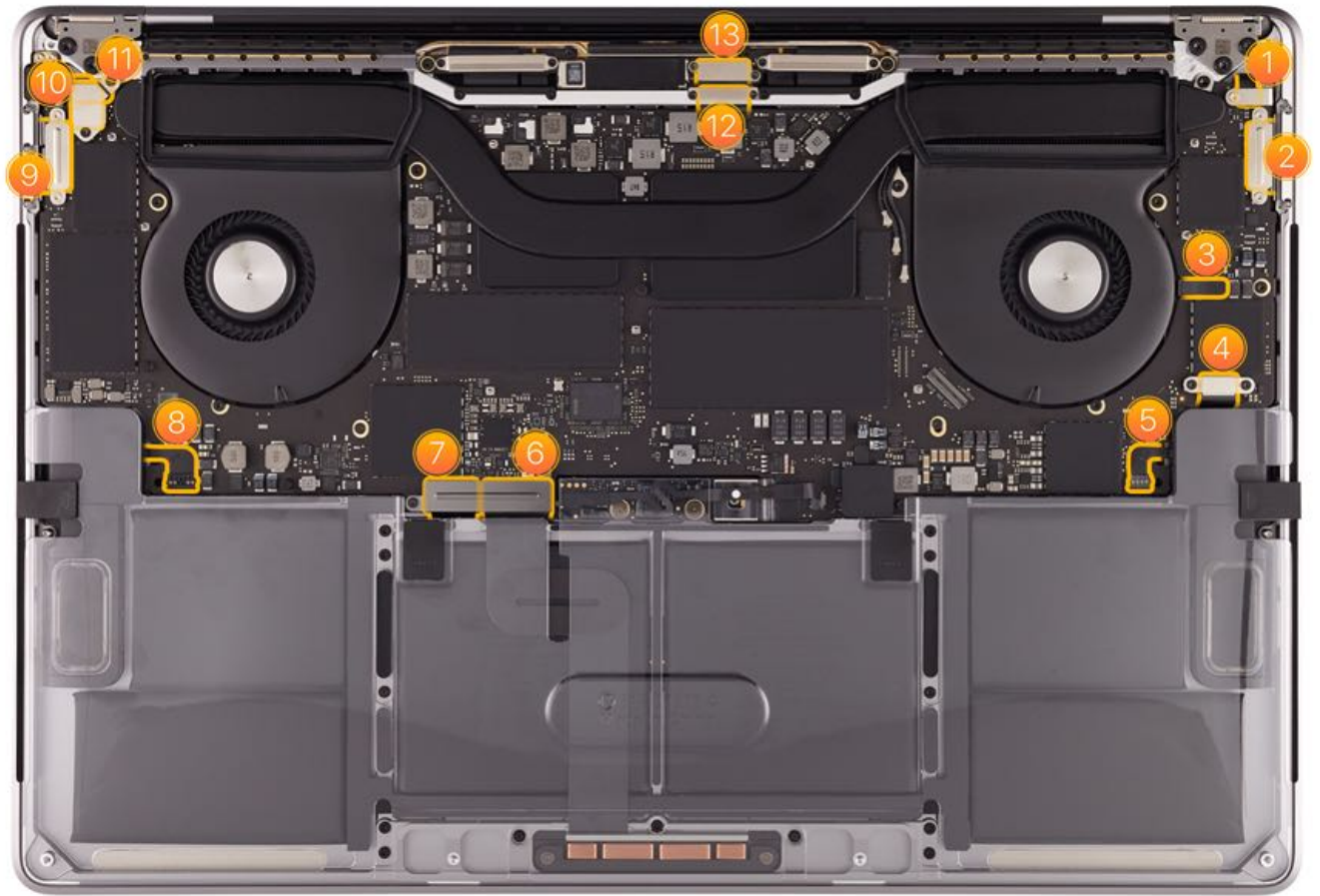
Connector Name	Locations for MacBook Pro (15-inch, 2017) and Earlier	Locations for MacBook Pro (15-inch, 2018) and Later
Touch Bar touch	1	1
Left I/O board	2	2
Microphone	3	3
Touch Bar display	4	4
Left speaker	5	5
Keyboard flex cable	6 (separate cowling)	6 (cowling shared with 7)
Trackpad flex cable	7 (separate cowling)	7 (cowling shared with 6)
Customer Data Migration (CDM)	8 *	--
Right speaker	9	8
Right I/O board	10	9
Audio board	11	10
Touch ID board	12	11
eDP flex cable	13 and 14	12 and 13

* **Important:** Do not disconnect the Customer Data Migration (CDM) Tool connector unless you are performing Data Migration. The CDM connector only applies to MacBook Pro (2016 and 2017) models.

Connectors, MacBook Pro (15-inch, 2016 and 2017):



Connectors, MacBook Pro (15-inch, 2018 and 2019):

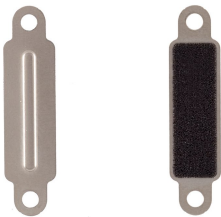


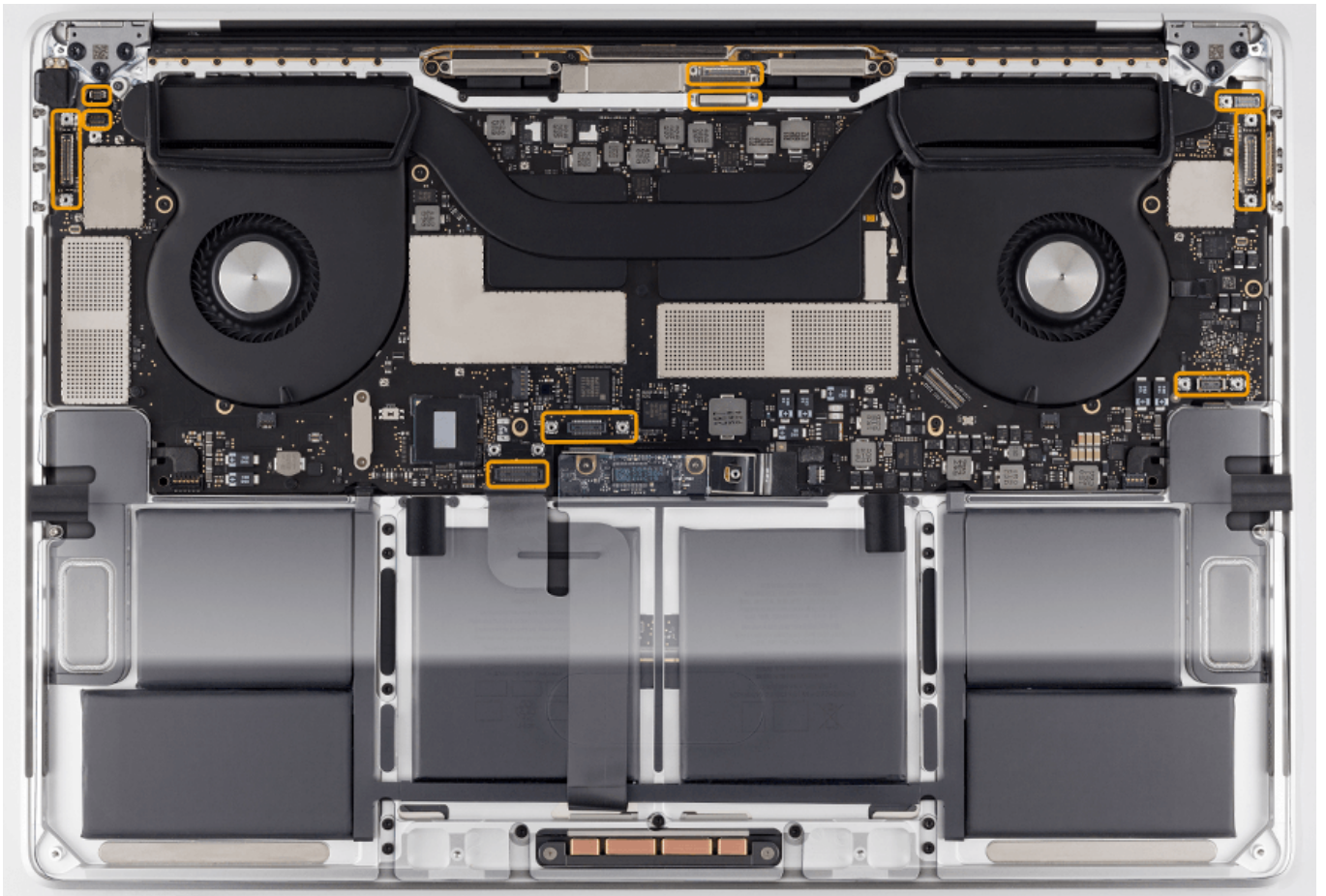
2. Remove the T3 screws from the cowlings marked above, then disconnect the low-profile platform flex connectors with a black stick.

Caution:

- Do not disconnect the Touch Bar display flex cable at either corner. Inserting a black stick at the corner can damage the connector on the logic board. Insert the black stick only in the center of the flex connector.
- Do not disconnect the USB-C flex cables from either side and not from the center. Inserting a black stick in the center of the flex connector can damage components within the connector on the logic board.

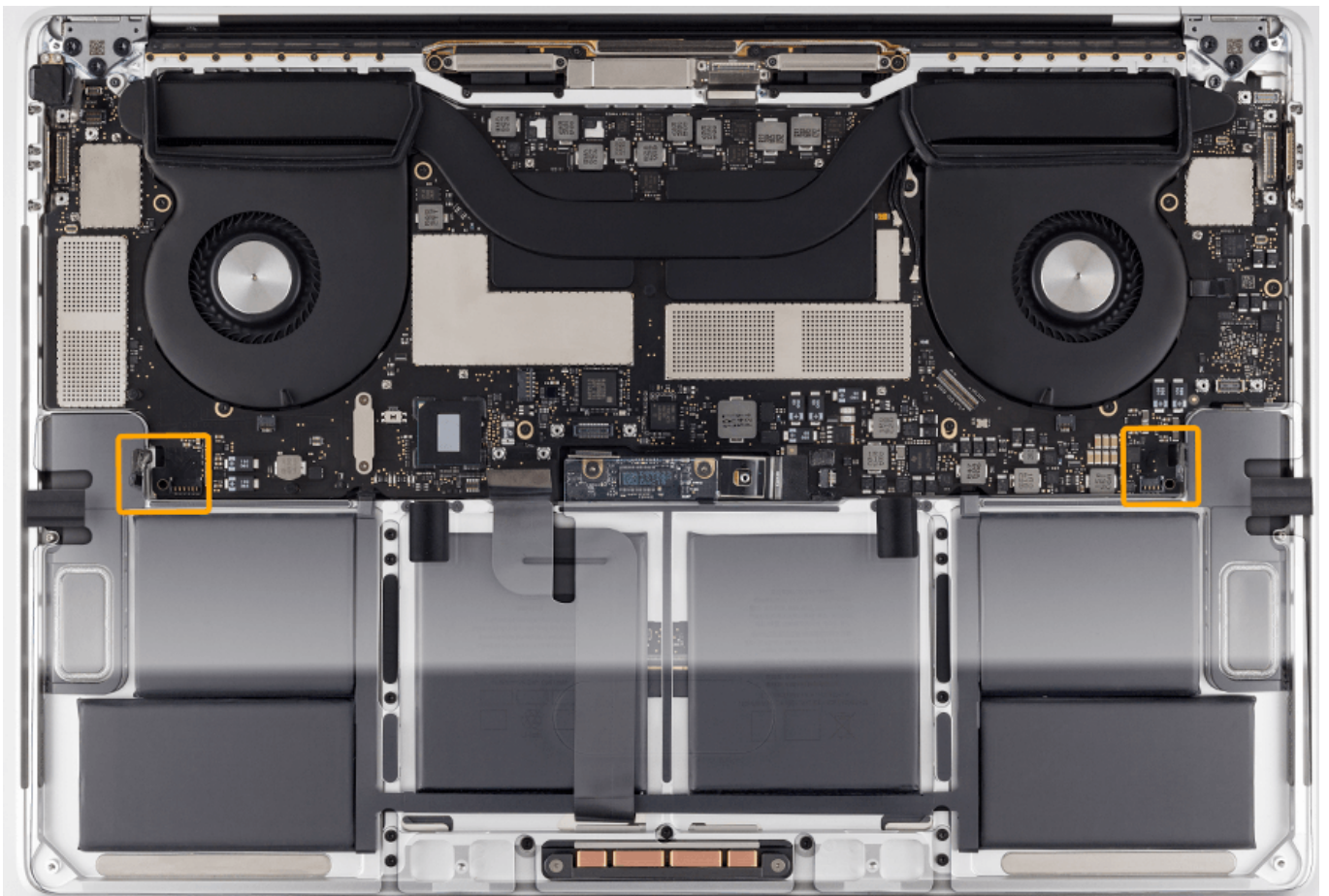
Note: For MacBook Pro (15-inch, 2016 and 2017), the left and right I/O boards have attached cowlings. For MacBook Pro (15-inch, 2018 and 2019), the cowlings detach when the screws are removed.



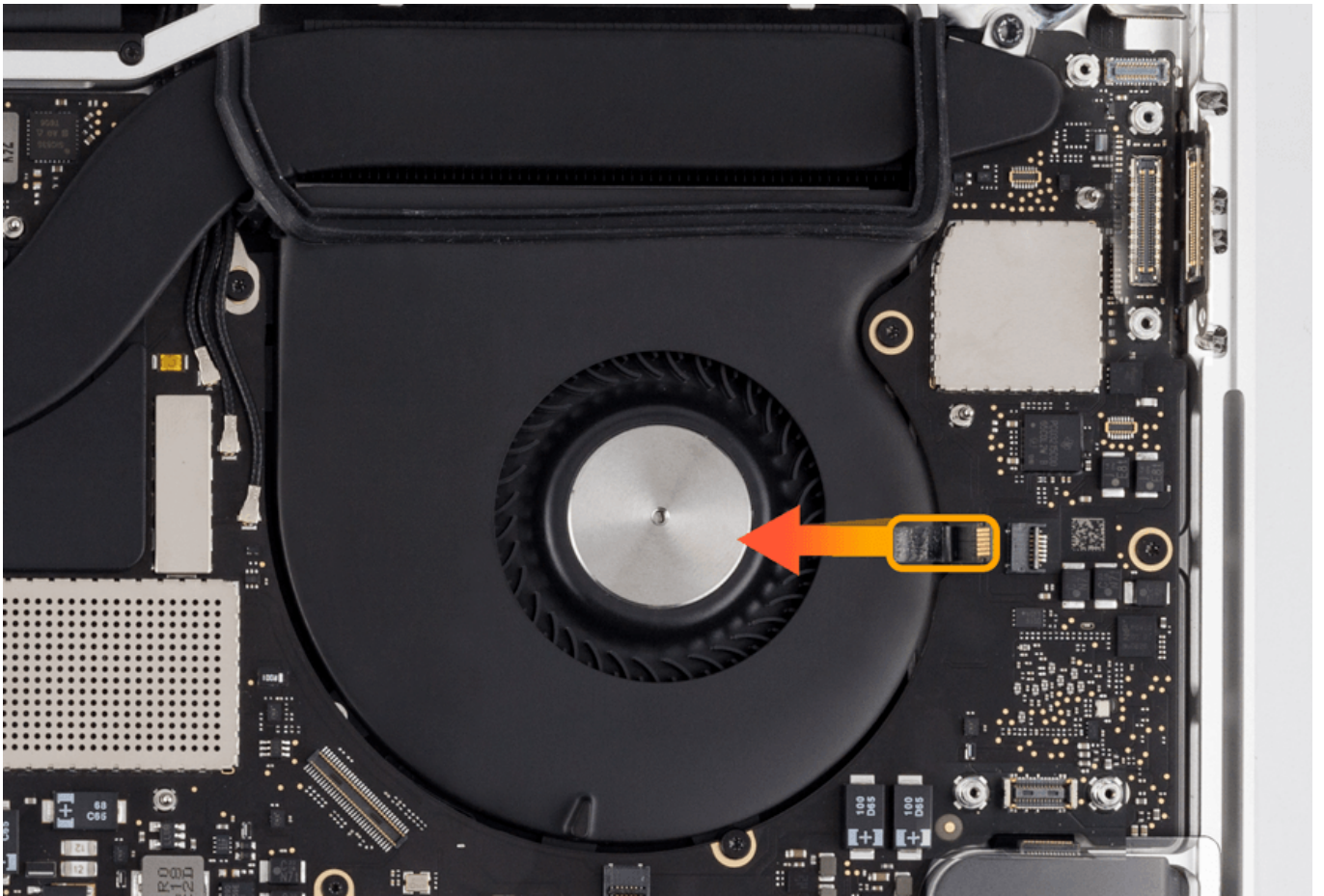


3. Disconnect the two vertical insertion (JST) speaker flex cables.

Note: The flex cables are adhered to the logic board with adhesive. Use a black stick to gently remove the flex from the board.



4. Disconnect one locking lever cable. Peel back the Mylar and use a black stick to flip up the locking lever and disconnect the flex cable.



5. Remove two T8 screws from the heat sink.

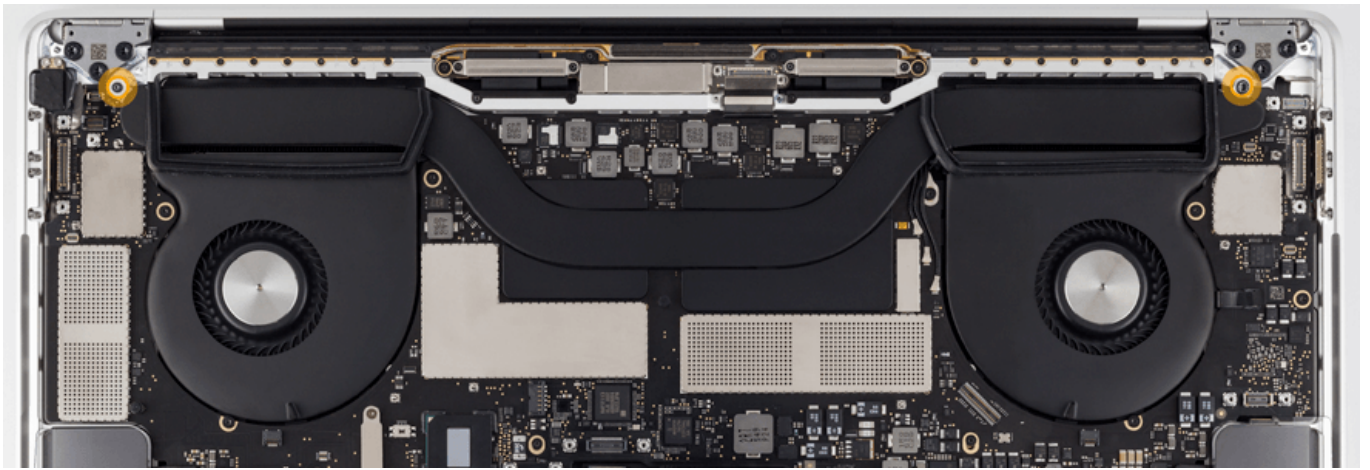
- T8: 923-01502 (left)



- T8: 923-01505 (right)

Note: The right screw is a screw within a screw.





6. Remove five T5 screws (1), one long T5 screw (2), and two T3 screws (3) from the logic board.

- T5 screws: 923-01500



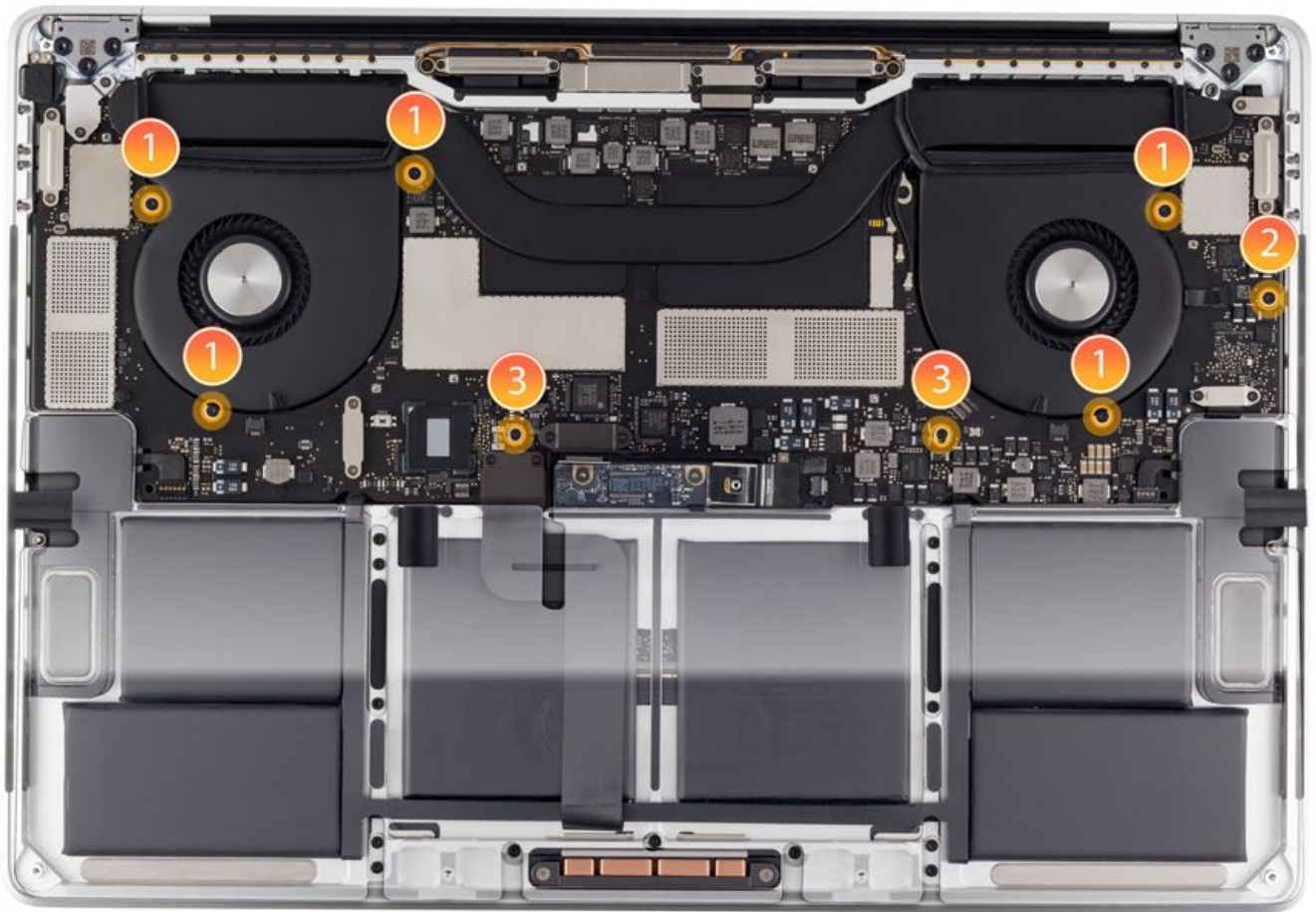
- T5 screw (long): 923-01498



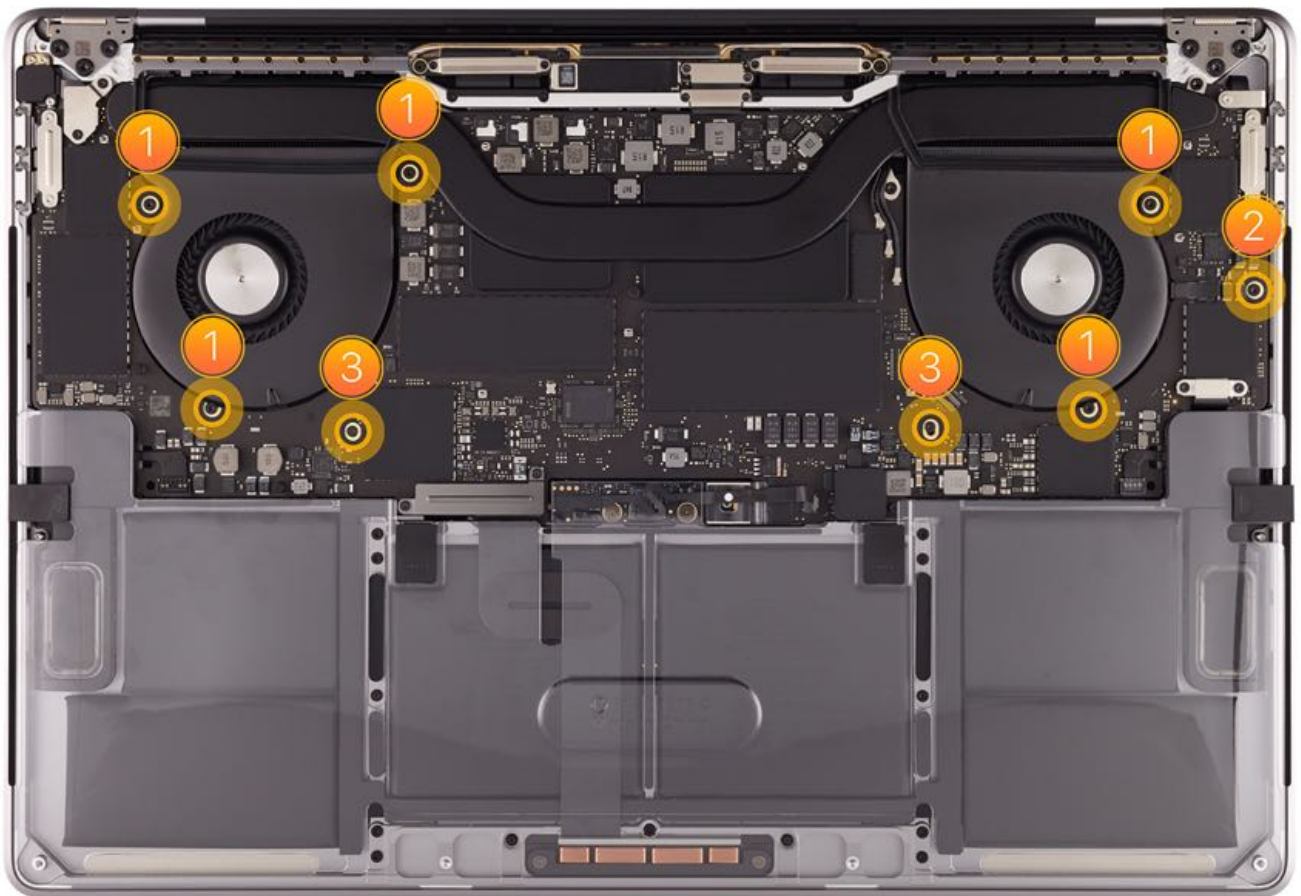
- T3 screws: 923-01497



Screw Locations, MacBook Pro (15-inch, 2017) and earlier:



Screw Locations, MacBook Pro (15-inch, 2018 and 2019):

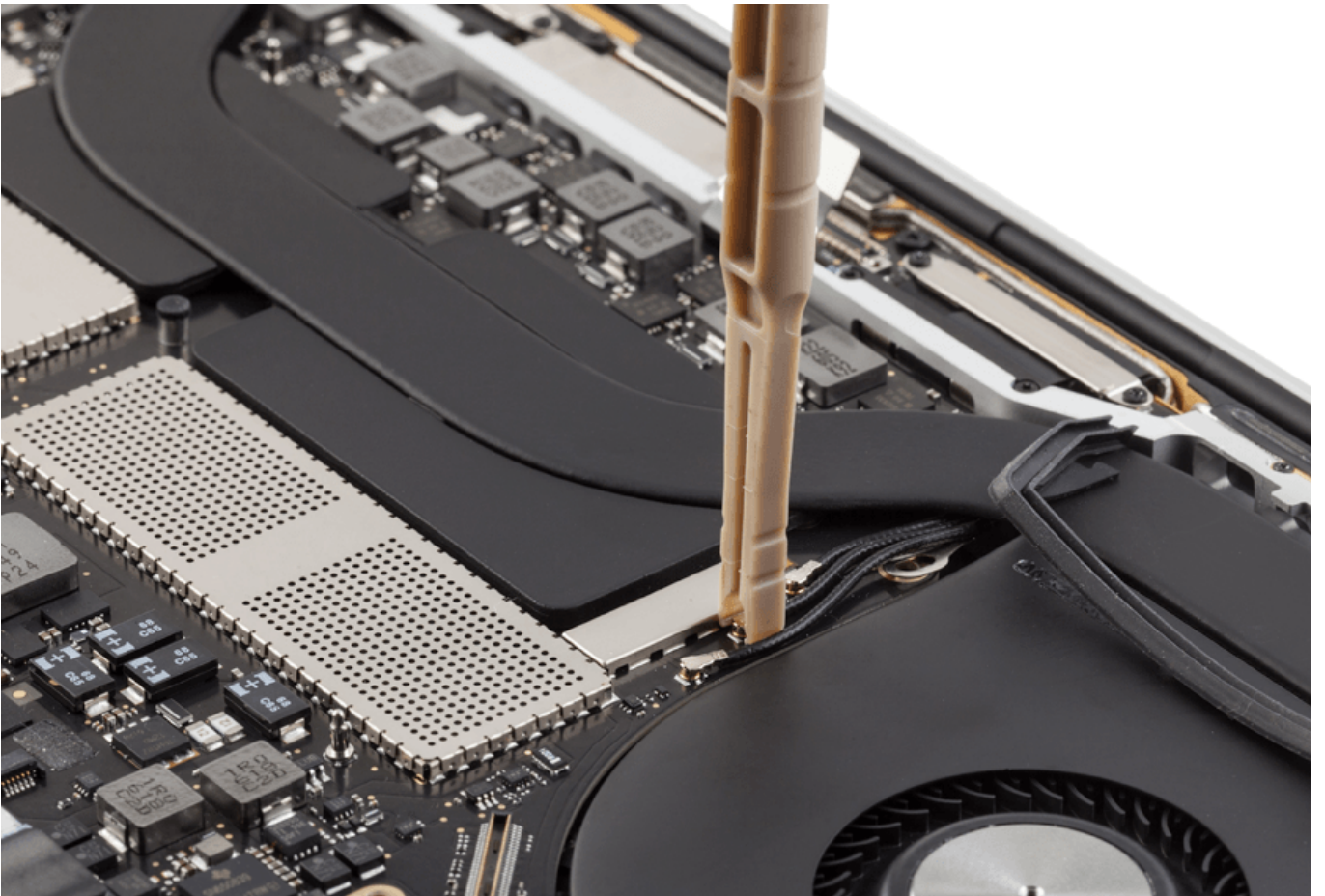


7. Remove the T5 antenna grounding screw.

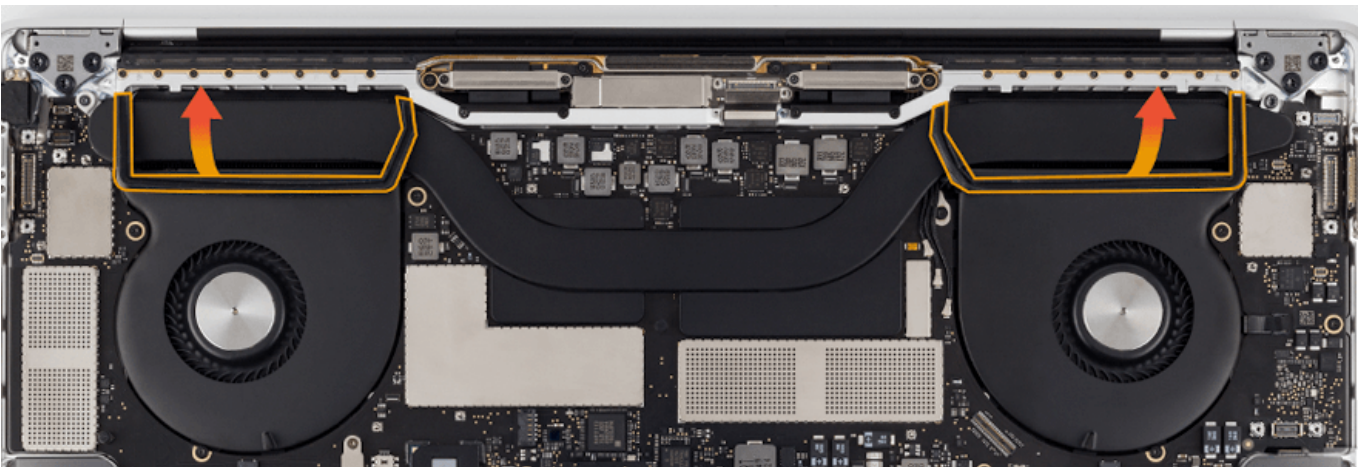
- T5: 923-01500



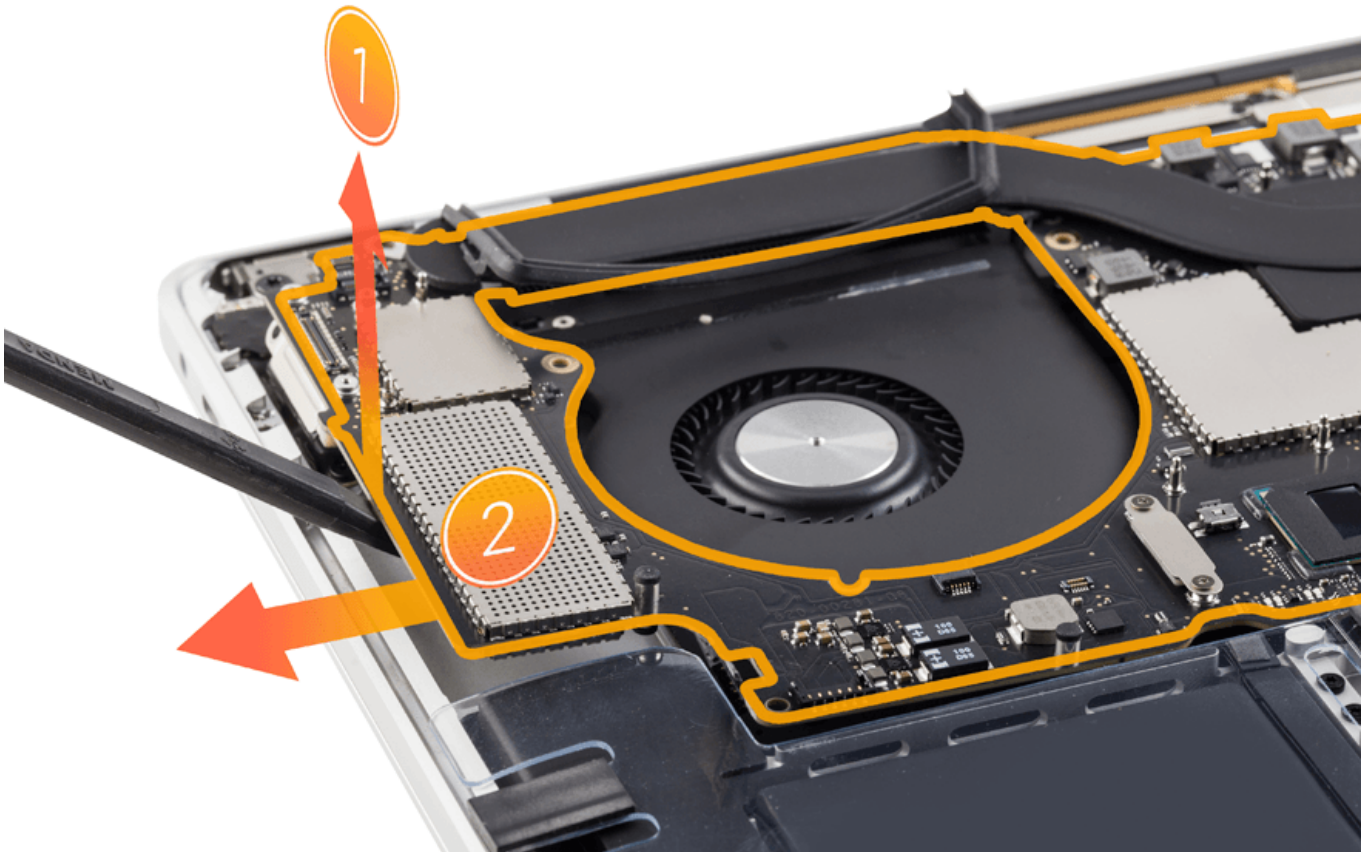
8. Use the antenna removal tool to disconnect the wireless and Bluetooth antennas.



9. Lift the thermal ducts up from, but not off of, the fans.



10. Use a black stick to gently lift the board up and out from the top case.



Steps For Reassembly

Note: Before ordering a replacement logic board for MacBook Pro (15-inch, 2018 and 2019), refer to [TP1721: Repair Requirements based on Graphics Configuration](#) to find out how to determine the correct part number.

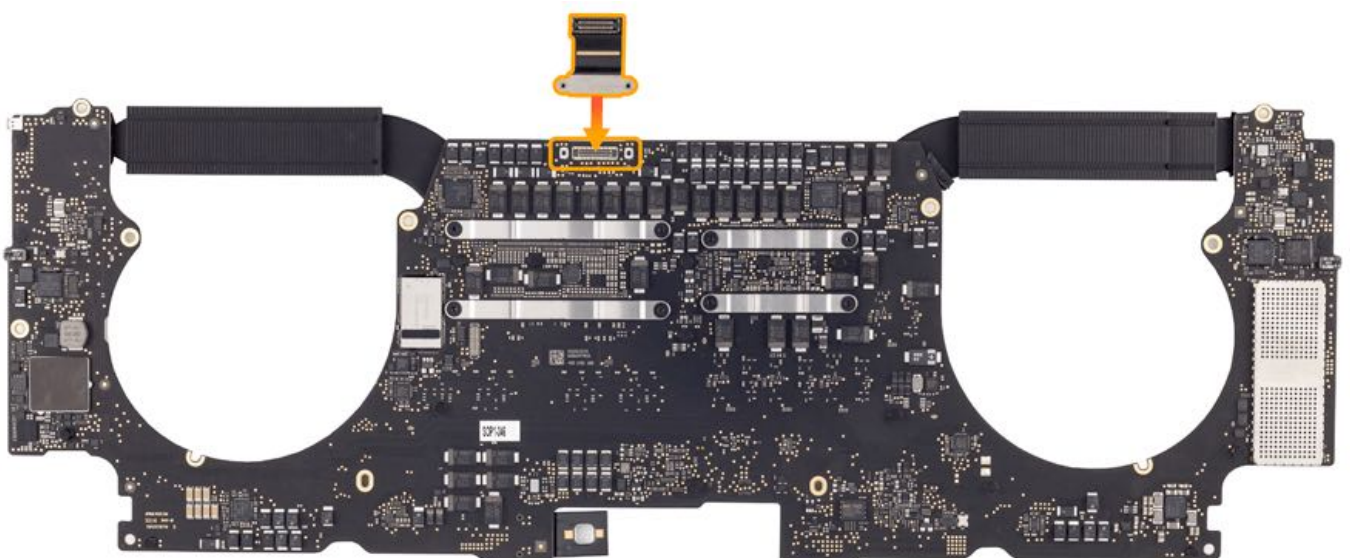
Reassemble in reverse order of removal steps.

Caution: Be sure no cables are caught under the logic board before attaching the antennas and screwing down the logic board. Bending the cables under the board can cause damage to the cables.

Important: If the logic board is replaced, the Touch ID board must also be replaced. See [RP1301: Touch ID Board](#).

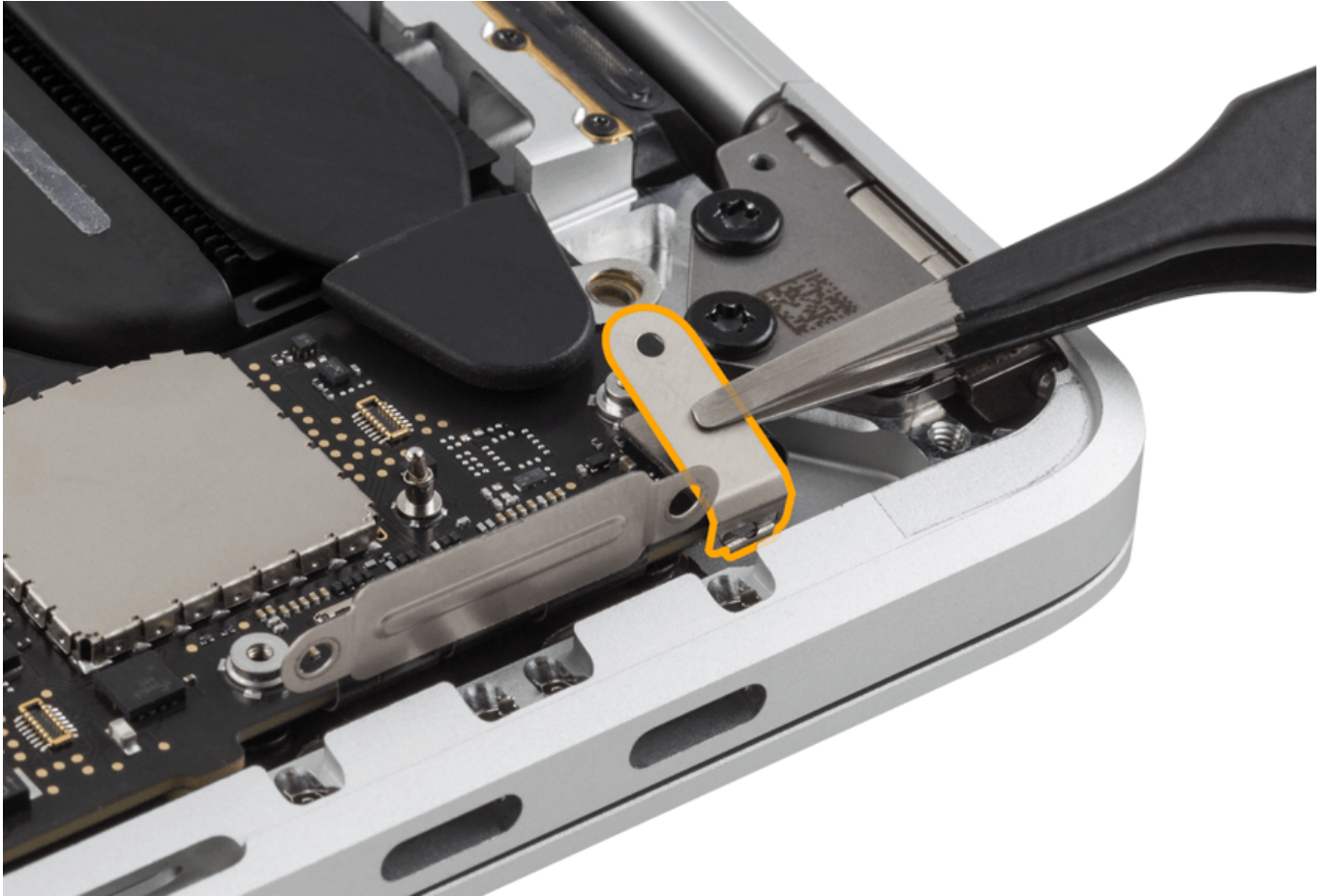
1. If you are installing a replacement logic board, remove and transfer these parts to the replacement board:

- [Heat sink](#)
- [eDP flex cable](#)



2. **Note:** There is a hook on the Touch Bar touch connector that needs to be fastened when reinstalling the Touch Bar touch

cowling. It is helpful to use tweezers.



3. When reconnecting the antennas, use tweezers to align the antenna head with the connector on the logic board. Then use the flip side of the antenna removal tool to make the connection.

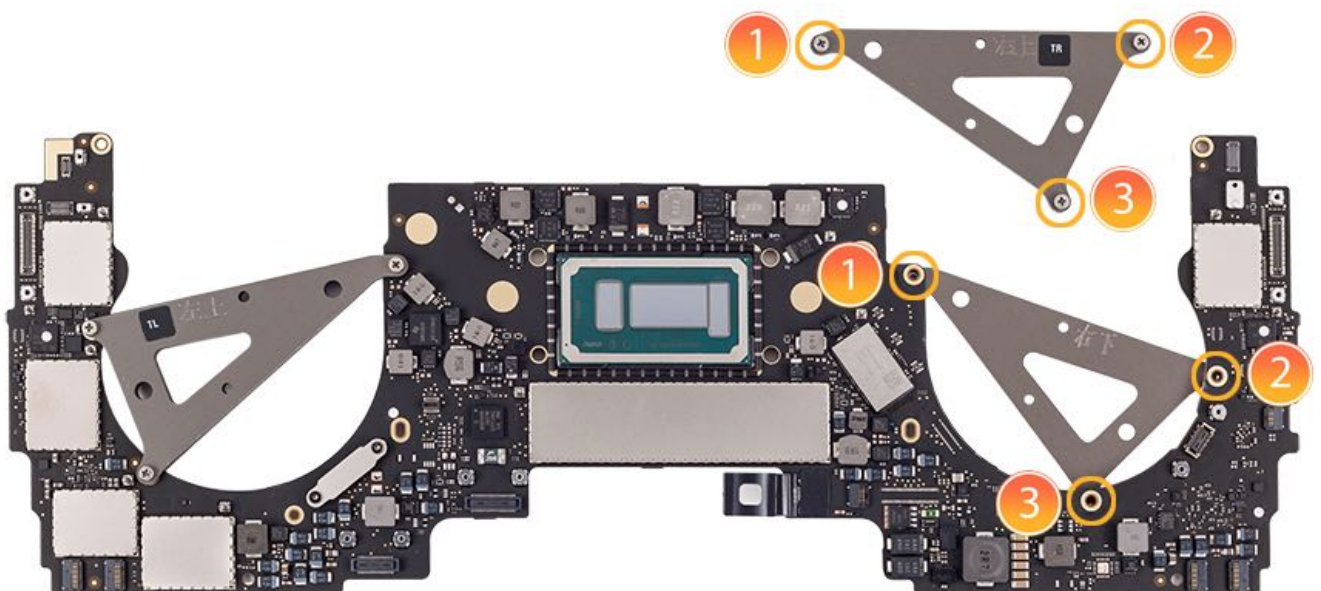




4. Transfer the two triangular stiffeners from the replacement logic board to the known-bad board.

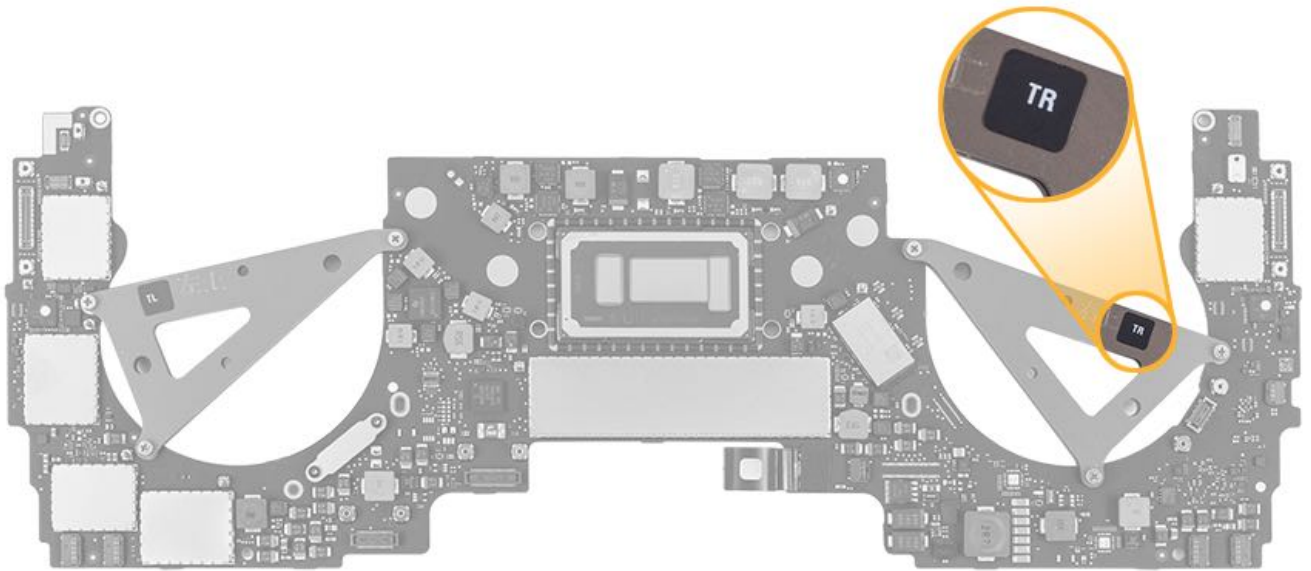
Caution: The triangular stiffeners must be placed on the known-bad board before returning to Apple Service or the logic board may be damaged during shipping.

- Loosen the three Phillips #00 captive screws from the top of the stiffener.
- Separate the two halves of the stiffener and align them onto the known-bad board.
- Tighten the screws and repeat these steps for the other triangular stiffener.



Note: The stiffeners have labels for position identification.

- TL-Top Left
- TR-Top Right
- BL-Bottom Left
- BR-Bottom Right



5. Reuse the packaging from the replacement board for the known-bad board:

- Place the known-bad board inside the reused ESD-safe bag.
- Position the bagged board in the foam frame.
- Close and seal the box, then return it to Apple Service.

Note: Although the logic board shown below is from a 13-inch MacBook Pro, the same packaging instructions apply to 15-inch models.





6. Reinstall the [clutch covers](#).
7. Reinstall the [BMU screw, reconnect the battery flex cable, and remove the battery cover](#).
8. Reinstall the [bottom case](#).



9. Caution:

- For MacBook Pro (2018 and 2019) this repair is not complete until the System Configuration has been performed. For instructions, refer to [TP1657: System Configuration for Macs with the Apple T2 Security Chip](#).

10. For MacBook Pro (2016 and 2017) Perform diagnostics.

- If the logic board has been replaced with a new board, run the following AST 2 diagnostic suites in the following order:
 - Trackpad Calibration Check
 - Touch ID and Touch Bar
 - Touch Bar Response
- If the old logic board has been reinstalled, verify the trackpad performance with the Trackpad Calibration Check found in AST 2.

11. Follow the instructions in [TP1314: Trackpad Calibration Check](#) to verify the trackpad performance after every repair.

Reinstalling Software That Came with the Computer

Reinstalling Software That Came with the Computer

This procedure requires an Internet connection.

Note: In some situations, a user may have set a firmware password. The user must know the firmware password in order to reinstall OS X or macOS. If the user cannot remember the password, then refer to the technician instructions in [HT204455: How to set a firmware password on your Mac](#).

Important: Apple recommends that users back up their data before any software restore procedure. Back up essential files before installing OS X or macOS. Apple is not responsible for any loss of data. For instructions on using Time Machine, refer to [HT201250: How to use Time Machine to back up or restore your Mac](#).

For instructions on reinstalling the OS, follow the steps in [HT204904: How to reinstall macOS](#).

For more information about recovery mode, refer to [HT201314: About macOS Recovery](#).

Touch ID Board

First Steps



Warning:

- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

Important:

- Only Apple-certified technicians should perform this procedure. For more information, refer to [OP1859: About Apple service certifications](#).
- Wear an ESD wrist strap and take precautions to avoid ESD.

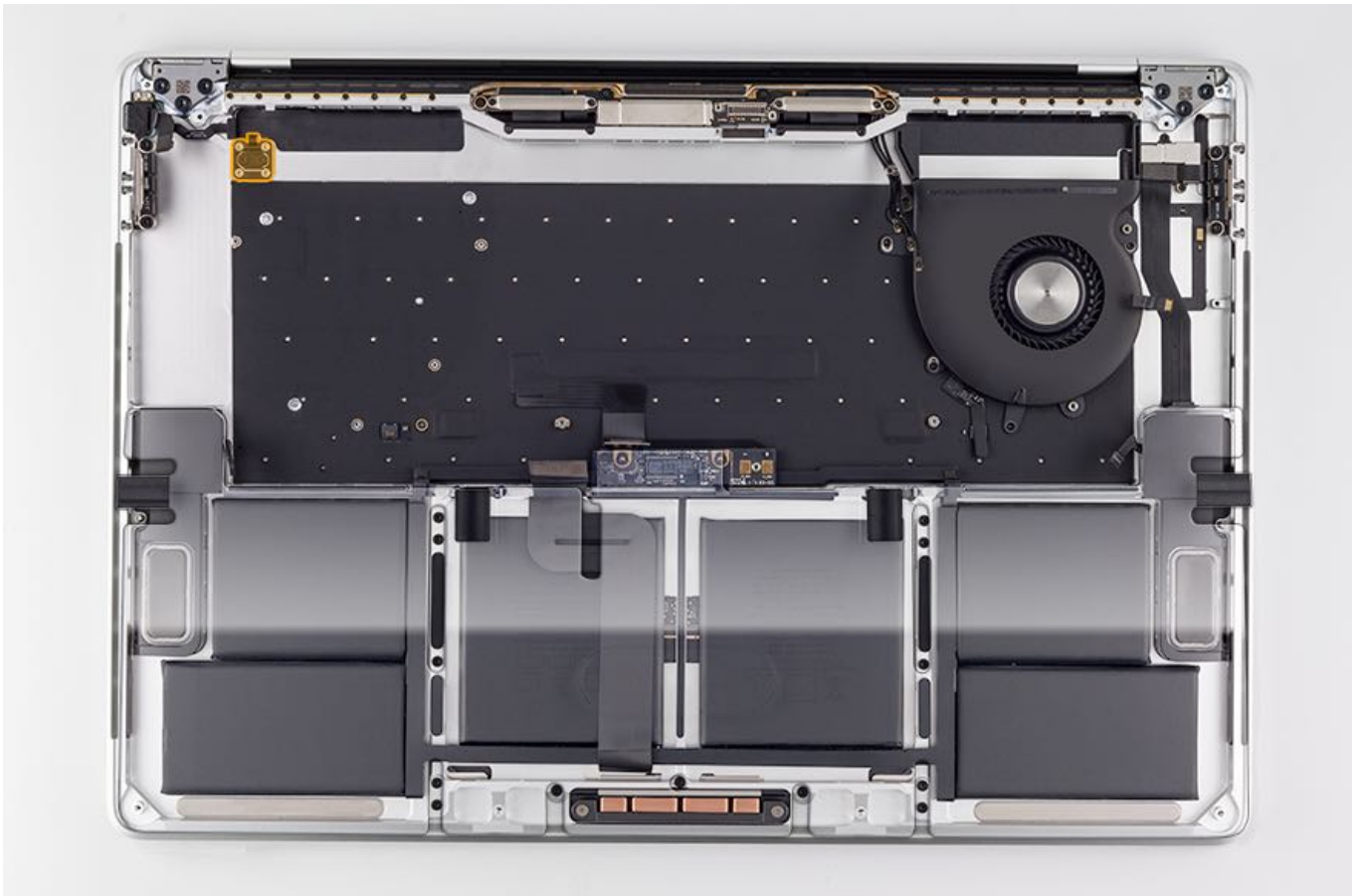
Caution:

- For MacBook Pro (2018 and 2019) this repair is not complete until System Configuration has been performed. For instructions, refer to article [TP1657: System Configuration for Macs with the Apple T2 Security Chip](#).

Remove:

- [Bottom case](#)
- [Attach battery cover and disconnect battery](#)
- [Clutch covers](#)
- [Logic board](#)
- [Right fan](#)

For video instruction, refer to [SV330: Touch ID Board Replacement Video](#).



Tools

- Alignment kit including Touch ID alignment tool and edge guide (923-01586)

Note: Your tool may differ in color.

- Torx T3 screwdriver
- ESD-safe tweezers



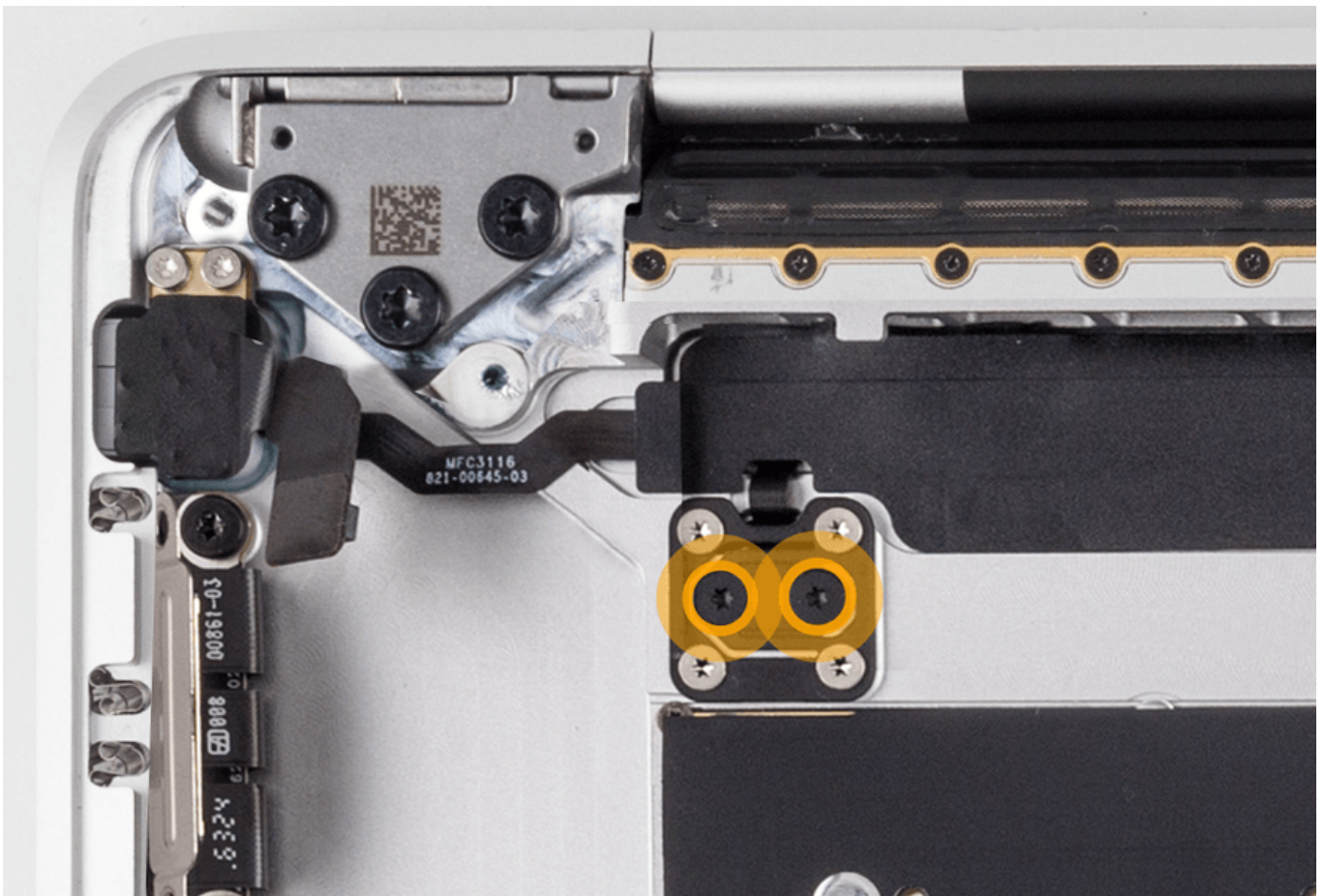
Steps For Removal

Important: The Touch ID board is paired with the logic board.

- For MacBook Pro (15-inch, 2016 and 2017): When the Touch ID board is replaced the logic board must also be replaced.
- For MacBook Pro (15-inch, 2018 and 2019): The Touch ID board (661-10344) can be replaced on its own. The logic board does not also have to be replaced.

1. Remove the two T3 screws from the center of the flexure.

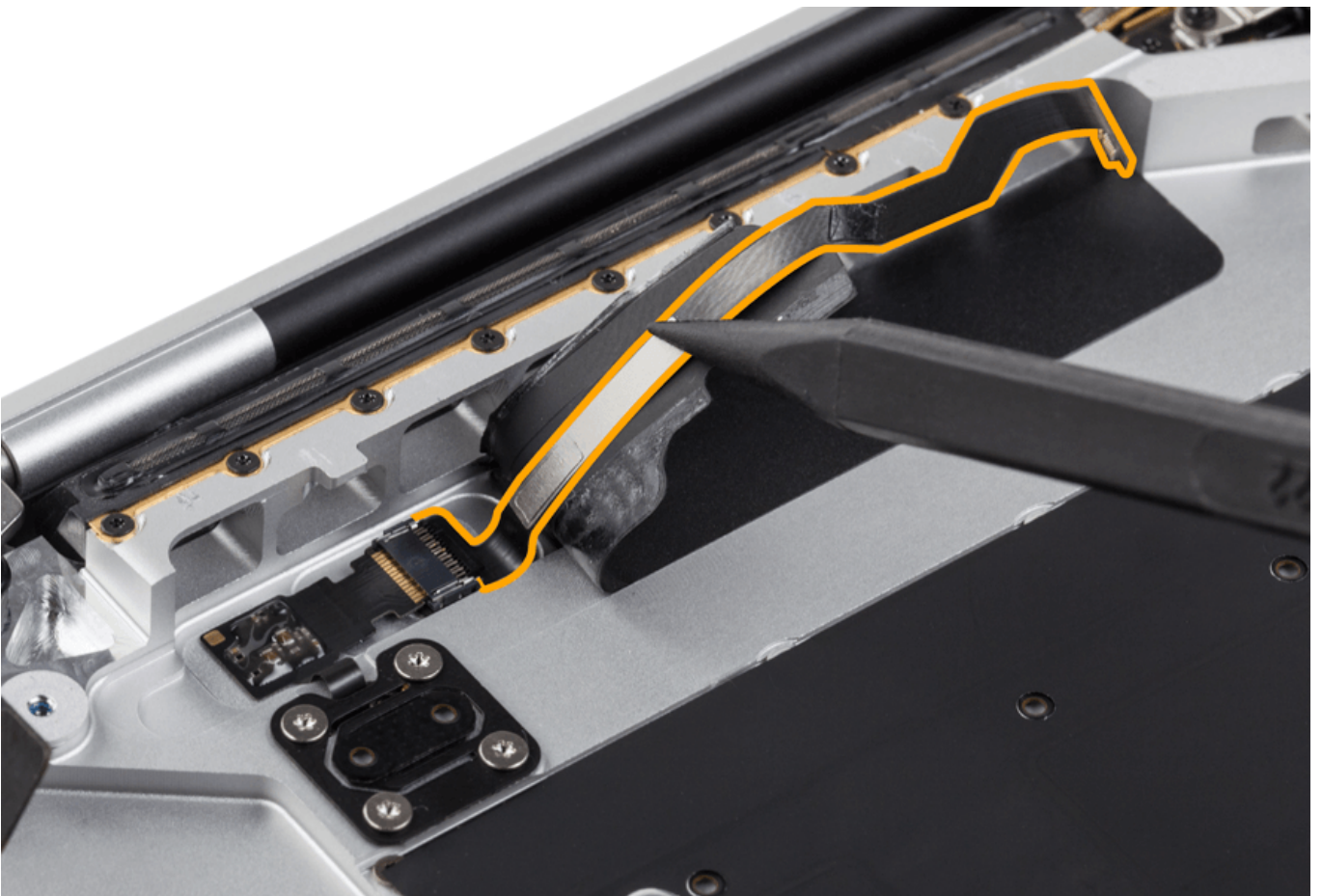
- T3: 923-01442



2. Use a black stick to peel the Mylar cover off the Touch ID board flex cable.



3. Gently hold back the flex cable with a black stick to expose the locking lever connector.



4. After flipping up the locking lever, use tweezers to loosen the adhesive and disconnect the flex cable.



5. Use the flat end of a black stick to peel up the flex cable from the top case.



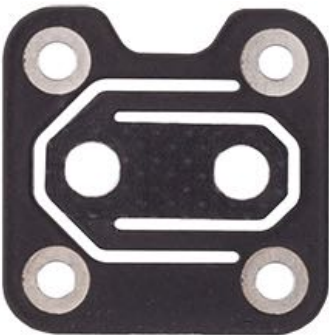
6. Remove the four T3 screws from the corners of the flexure.

- T3: 923-01443

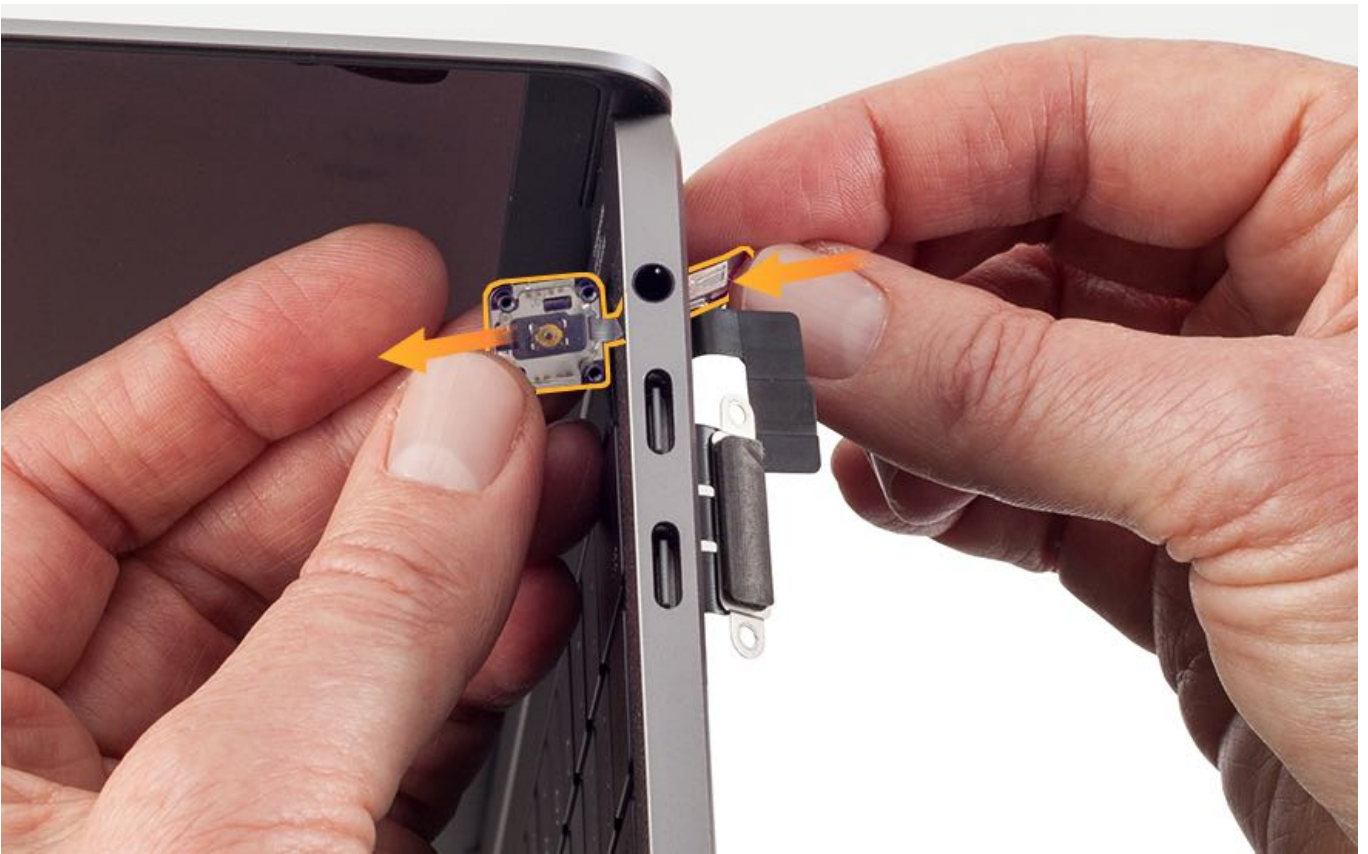


7. Use tweezers to remove the flexure from the top case.

Note: The outside border of the flexure is keyed on one edge to fit the flex cable. This indicates the proper orientation when reinstalling the flexure.

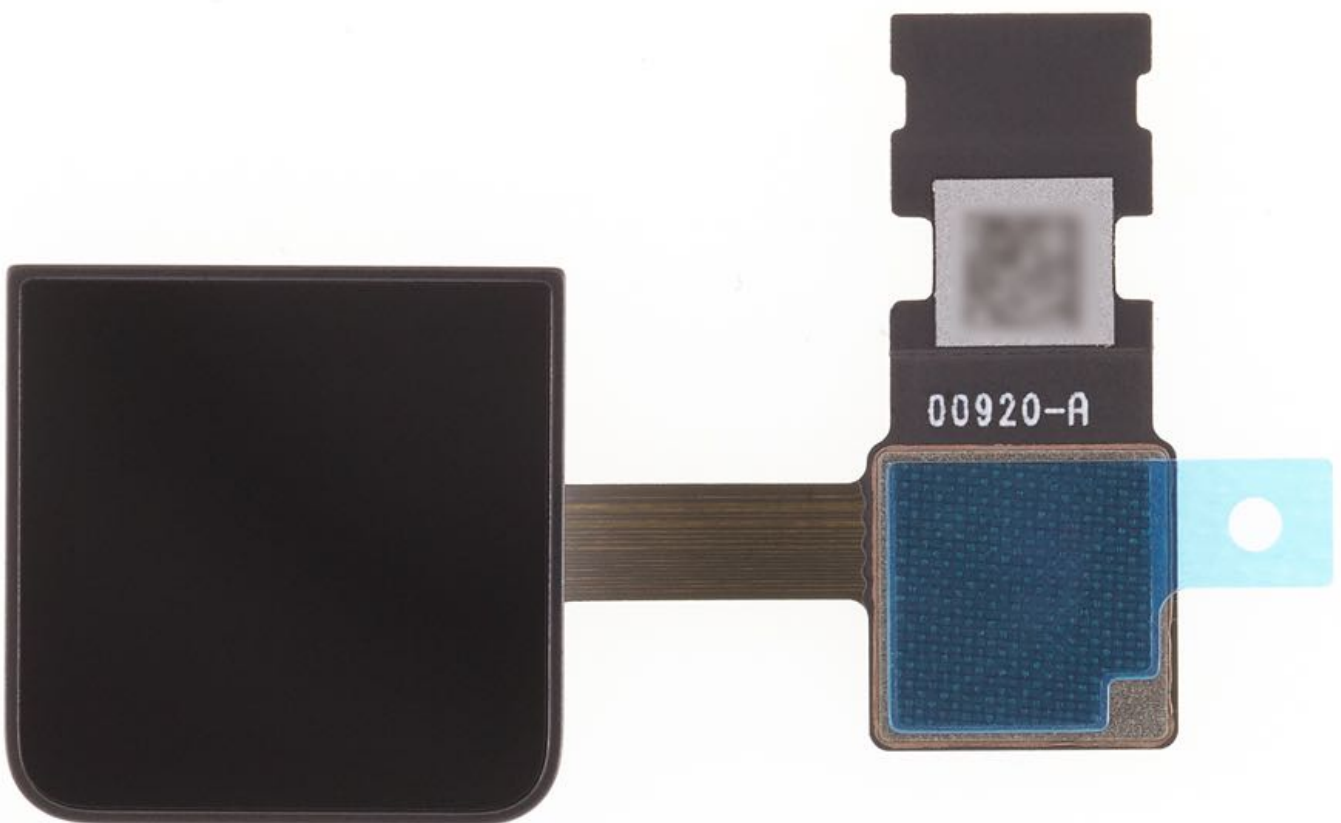


8. Open the display and stand the computer assembly on its side. With a hand on each side of the top case, support the Touch ID board as you thread the flex cable through the slot. Remove the Touch ID board from the keyboard side of the top case.



Steps For Reassembly

Note: When installing a replacement Touch ID board, remove the protective film from the glass surface. Keep the adhesive film on the flex cable until the cable is ready to reconnect.



1. With the computer on its side, support the Touch ID board as you thread the flex cable through the slot in the top case.

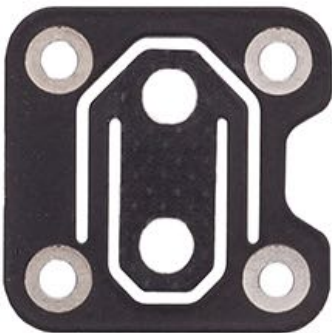


2. On the keyboard side of the top case, hold the Touch ID button in place.
3. On the other side of the top case, reinstall the flexure and four corner screws.

- T3: 923-01443



Note: The flexure has a keyed edge that fits the flex cable. Before installing screws, verify the four silver circles are visible. If you do not see the silver circles, flip over the flexure.





4. Press the Touch ID button to verify it makes a clicking noise. If the button does not move at all or moves but does not click, refer to [RP1354: Touch ID Shim](#) for details.



5. If the click is correct, attach the Touch ID alignment tool by inserting the three flaps of the tool into the Touch ID bay.

6. Hold the tool in place while reinstalling the two center screws in the middle of the flexure.

- T3: 923-01442



7. Remove the Touch ID alignment tool, close the display, and place the computer flat on the ESD mat with the inside of the top case facing up.

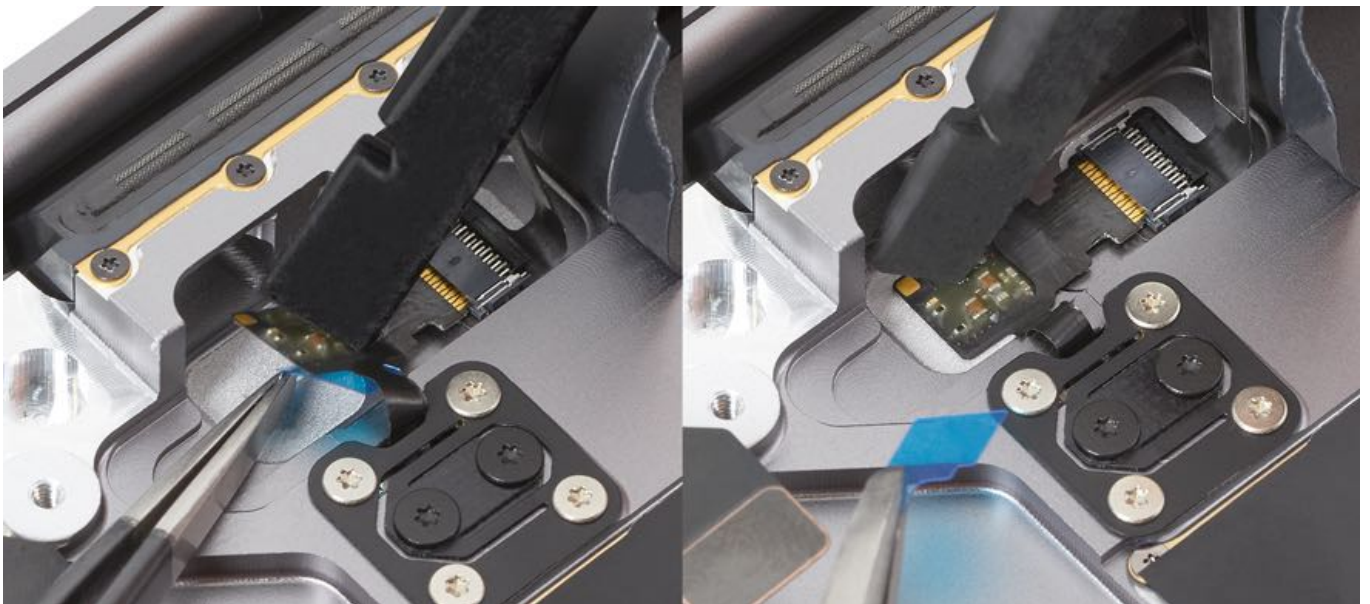


Caution: To prevent damage to the display, ensure the Touch ID alignment tool is removed before closing the display.

8. Reinstall the flex cable into the connector. Press the locking lever on the connector to secure the flex cable.



9. Use tweezers to remove the adhesive film from the flex cable. Then use a black stick to press and adhere the square area of the flex cable.



10. Check that the battery cover is in place and the flex cables are not bent or strained. Then turn over the computer and open the display.

11. Look directly at the Touch ID button. The spaces surrounding each side should appear equal, and the Touch ID button should align seamlessly with the Touch Bar.

12. Insert the tab of the Touch ID alignment tool into all four sides of the Touch ID button. The side between the Touch ID

button and the Touch Bar has a tighter fit.



13. Reinstall the [right fan](#).
14. **For 2016 and 2017 models only:** If you are installing a new Touch ID board, you must install a new [logic board](#).
15. **For 2018 and 2019 models:** If you are installing only a new Touch ID board, reinstall the original [logic board](#).
16. Reinstall the [clutch covers](#).
17. Reinstall the [BMU screw, reconnect the battery, and remove the battery cover](#).
18. Reinstall the [bottom case](#).
19. **Caution:** For MacBook Pro (2018 and 2019) this repair is not complete until System Configuration has been performed. For instructions, refer to [TP1657: System Configuration for Macs with the Apple T2 Security Chip](#).
20. Follow the instructions in [TP1314: Trackpad Calibration Check](#) to verify the trackpad performance after every repair.

Touch ID Shim

First Steps



Warning:

- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

Important:

- Only Apple-certified technicians should perform this procedure. For more information, refer to [OP1859: About Apple service certifications](#).
- Wear an ESD wrist strap and take precautions to avoid ESD.
- For 2016 and 2017 models only: The logic board is paired with the Touch ID board. When replacing one, you must replace the other.
- For 2018 and 2019 models: The Touch ID board can be replaced without replacing the logic board. However, if the logic board is replaced the Touch ID board must also be replaced. Refer to [RP1301: Touch ID Board](#).

Remove:

- [Bottom case](#)
- [Attach battery cover and disconnect battery](#)
- [Clutch covers](#)
- [Logic board](#)



Tools

- Torx T3 screwdriver (magnetized)
- ESD-safe round-nose tweezers
- Shim kit, package of 3 (923-01519), not shown



Steps For Removal

Note: The Touch ID shim is a tiny, circular part. Make sure your work surface is completely clean. A clean surface allows easy location of the shim if it lands on the ESD mat during this repair.

1. Press the Touch ID button a few times to check its response:

- If the button feels too loose or does not click, a larger Touch ID shim is required.
- If the button feels too stiff or does not move, a smaller Touch ID shim is required.



2. Refer to [RP1301: Touch ID Board](#) to remove the Touch ID board.

3. Spread the tips of the round-nose tweezers, and use one tip to push the Touch ID shim out.



4. Retrieve the loose shim on the keyboard side of the top case. The Touch ID shim has a small bit of adhesive and may stick to the top case. The adhesive side of the shim is black and the opposite side is silver.





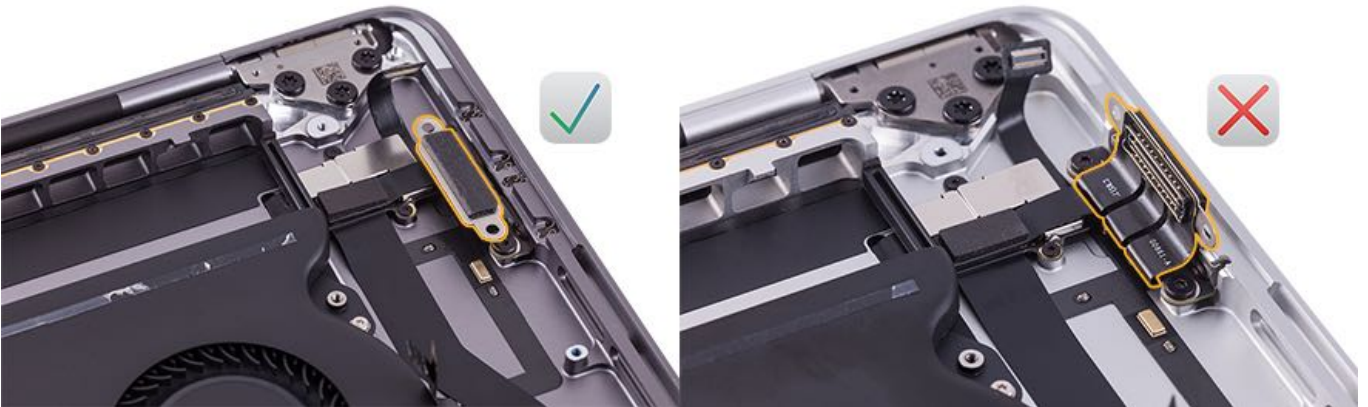
Steps For Reassembly

1. Replace the Touch ID shim with one of the supplied shims from the kit (923-01519), which are marked and organized by size.

- Use tweezers to remove the appropriate shim from the backing.
- Keep less than half of the shim on the tweezer head for easier installation.

2. Set the computer flat on the ESD mat.

Important: Be sure the battery cover is in position and the left and right I/O boards are flat.



3. Align the shim in the recessed circle on the top case.



4. Gently press the shim to activate the adhesive.



5. Refer to the following articles to complete the repair:

- [RP1301: Touch ID Board](#) to reinstall the Touch ID board in the top case and confirm that the new shim clicks and functions correctly.
- [RP1300: Logic Board](#) to reinstall the logic board.
- [TP1657: System Configuration for Macs with the Apple T2 Security Chip](#) to configure the computer for use.

6. Reassemble the computer.

7. Follow the instructions in [TP1314: Trackpad Calibration Check](#) to verify the trackpad performance after every repair.

Heat Sink

First Steps



Warning:

- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

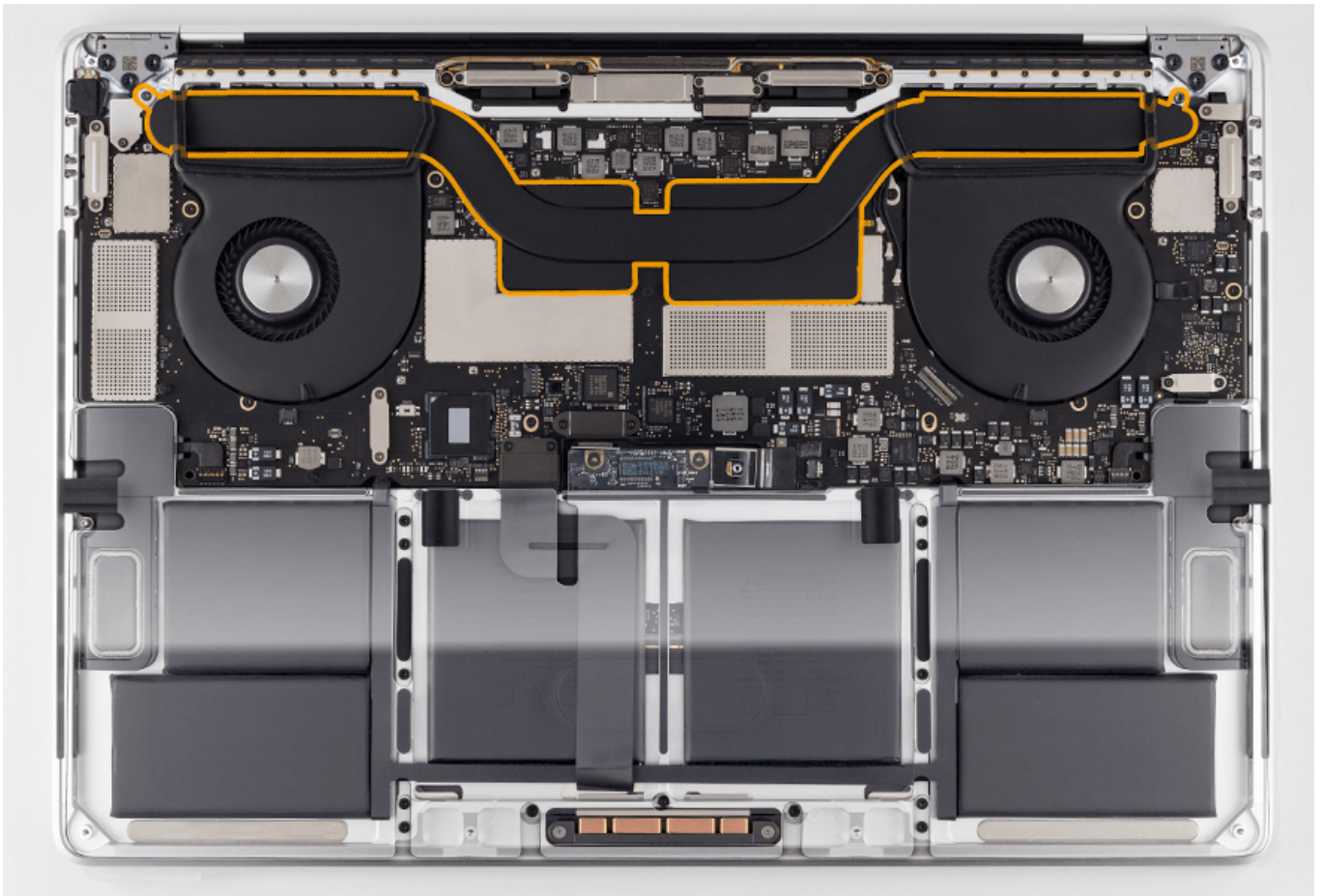
Important:

- Only Apple-certified technicians should perform this procedure. For more information, refer to [OP1859: About Apple service certifications](#).
- Wear an ESD wrist strap and take precautions to avoid ESD.

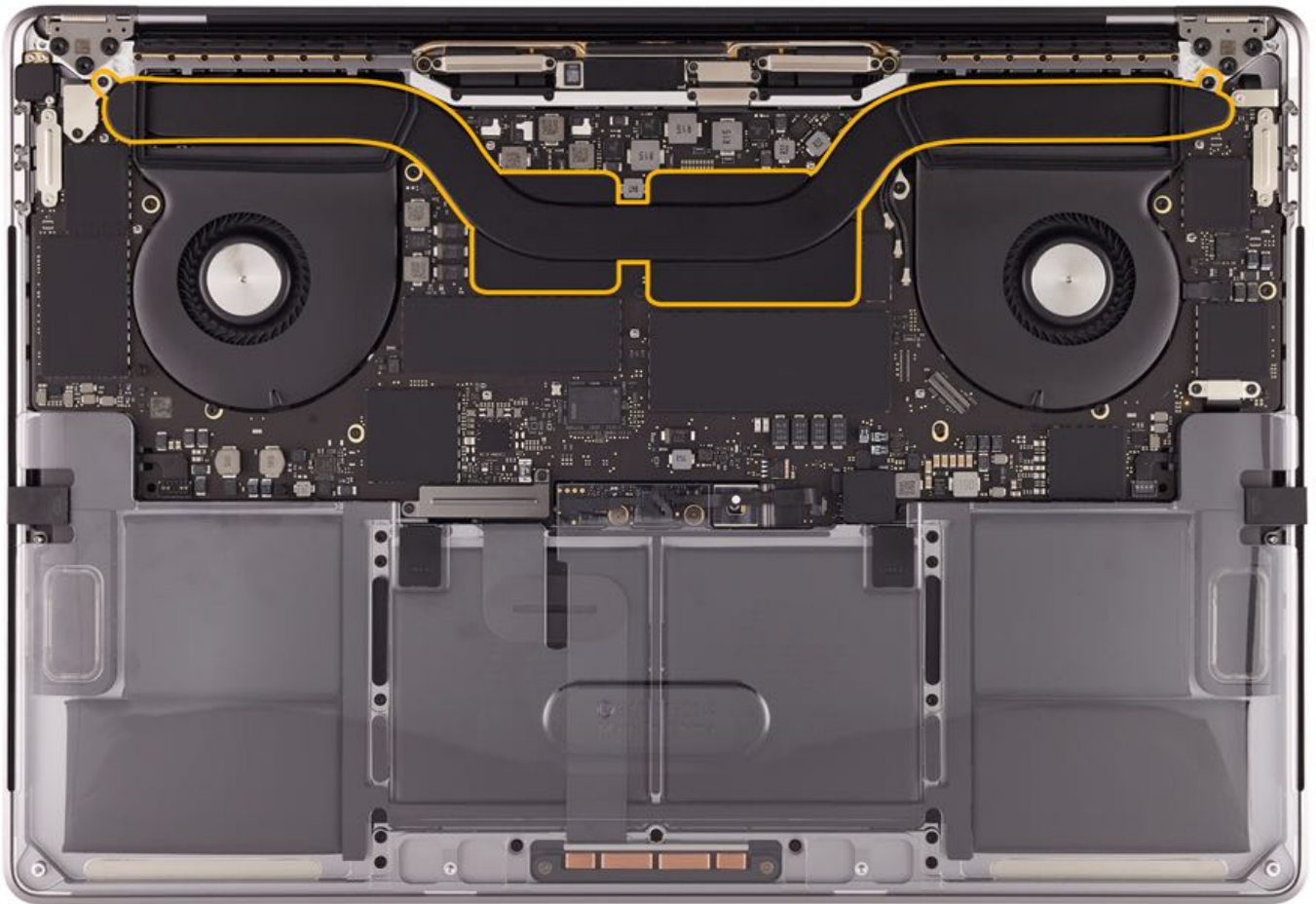
Remove:

- [Bottom case](#)
- [Attach battery cover and disconnect battery](#)
- [Clutch covers](#)
- [Logic board](#)

Heat Sink, MacBook Pro (15-inch, 2016 and 2017):



Heat Sink, MacBook Pro (15-inch, 2018 and 2019):



Tools

- Torx T5
- Thermal grease syringe (922-7144)
- Isopropyl alcohol (IPA) wipes



Steps For Removal

1. Turn over the logic board. Place the board on an ESD mat. Remove four T5 flexure screws from the CPU and four T5 flexure screws from the GPU.

- T5: Four 923-01507 (GPU)

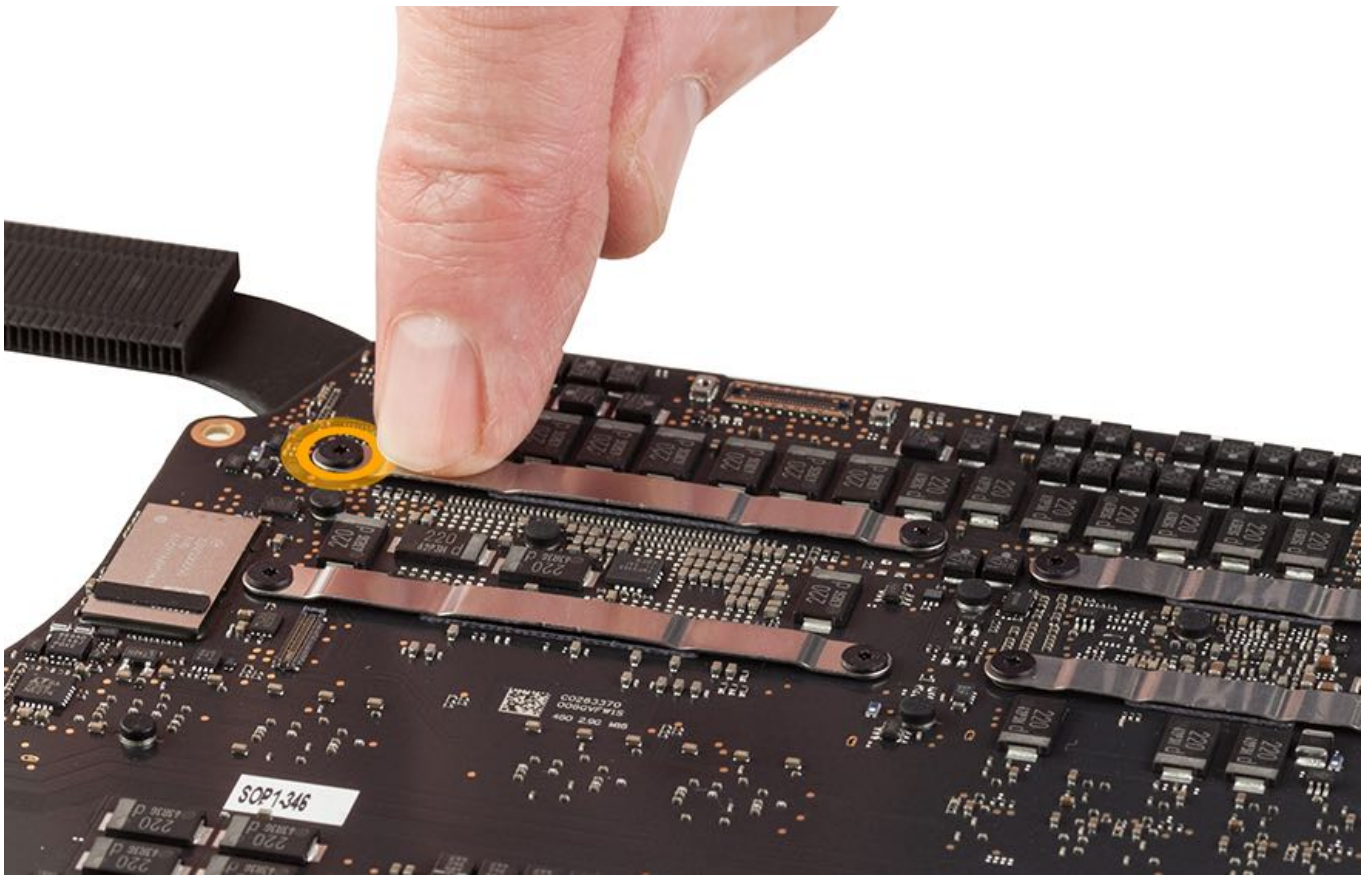
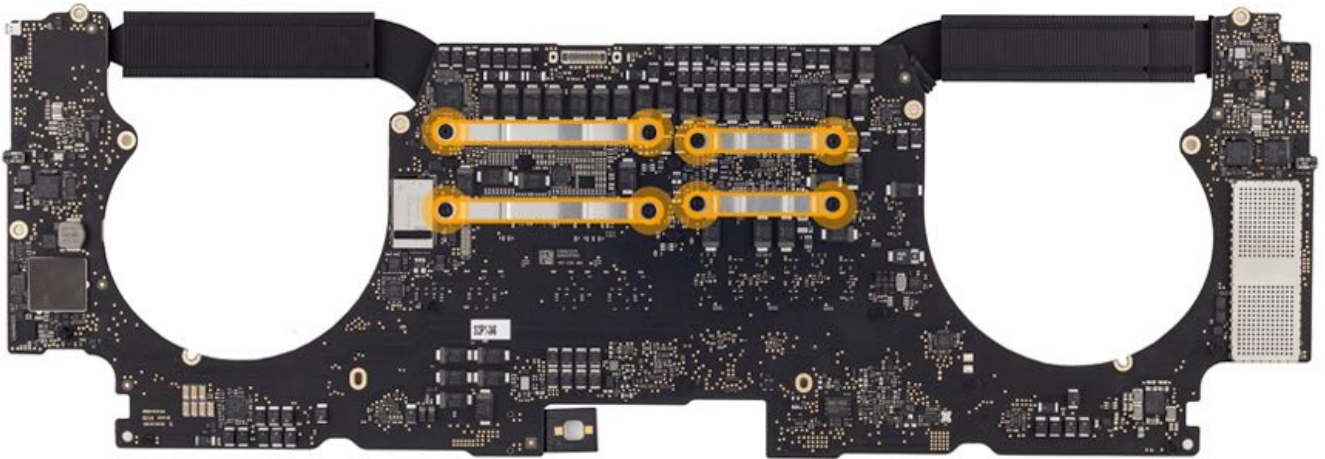


- T5: Four 923-01508 (CPU)



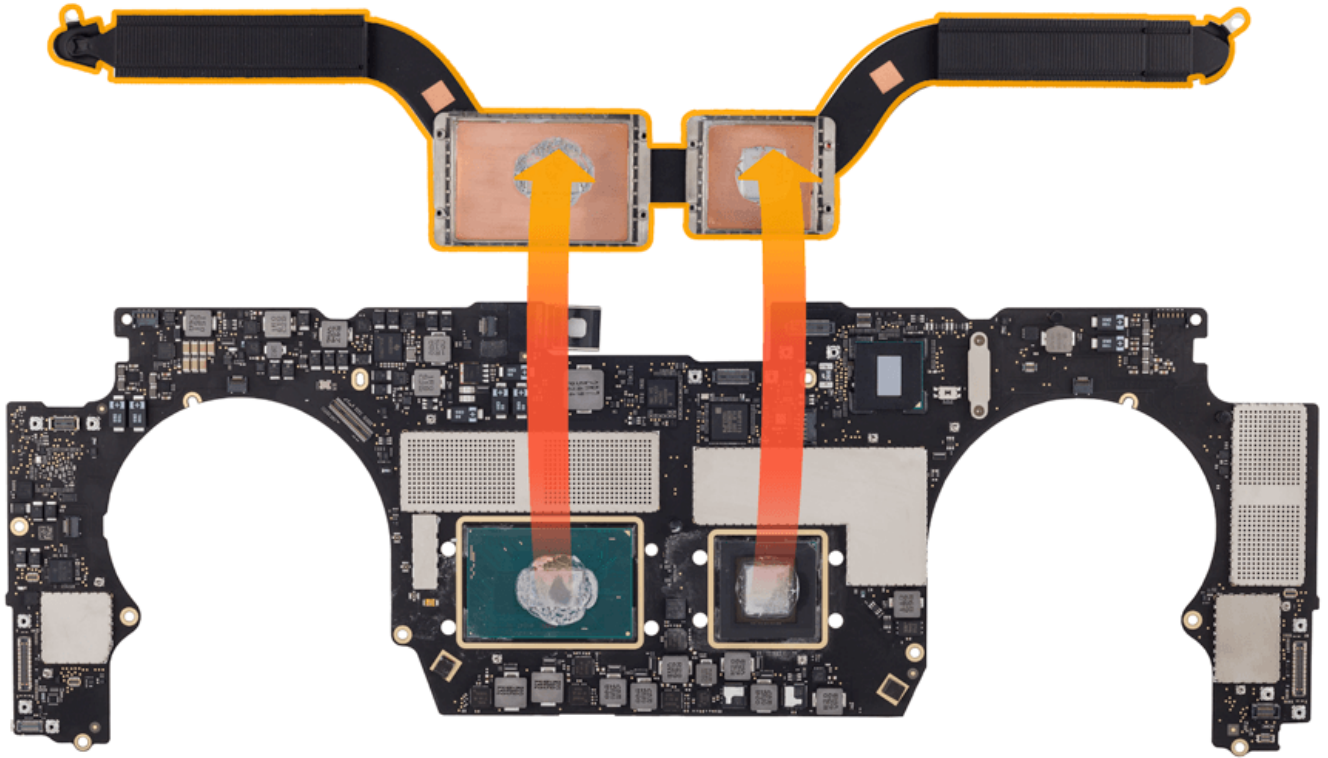
Note:

- The CPU flexures are longer than the GPU flexures.
- The heat sink flexures are under tension. Gently hold down the flexure when removing the screws on each flexure clip.



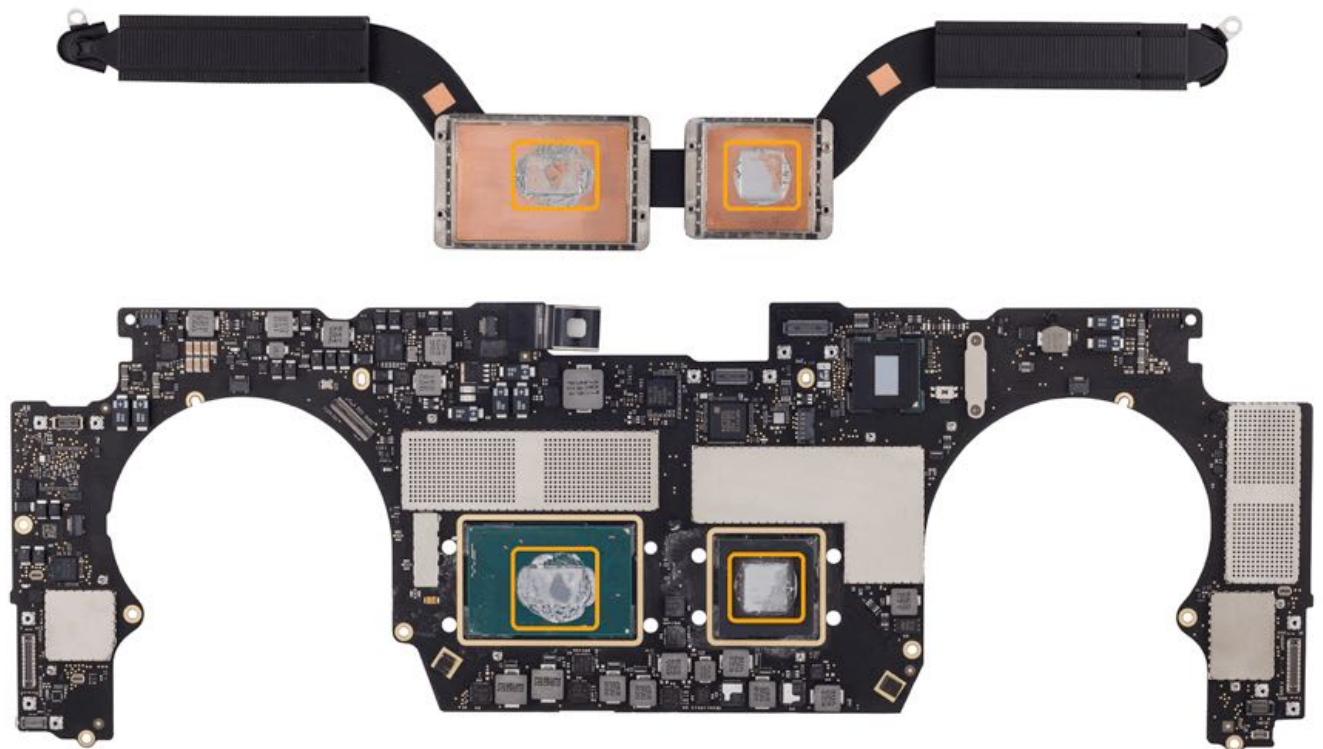
2. Gently lift the heat sink from the logic board.

Note: Always hold the heat sink by the body. Never hold the heat sink by the arm.

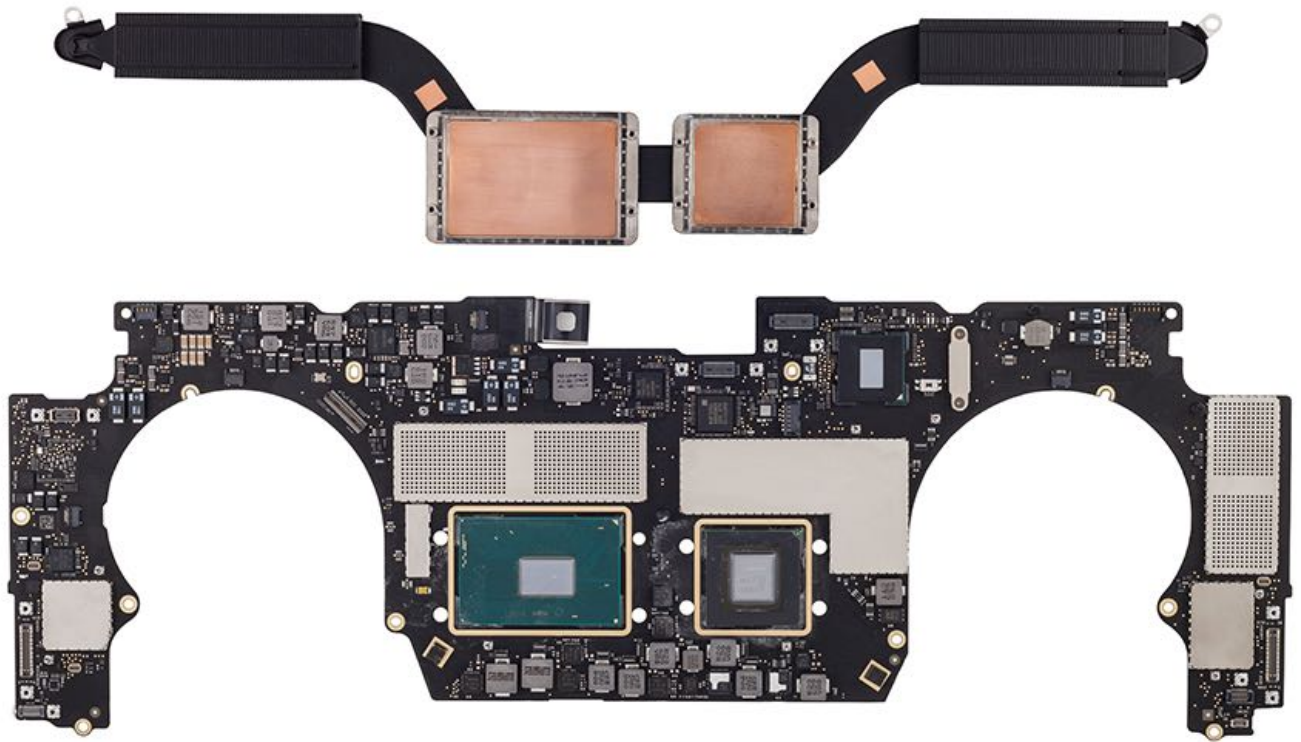


3. Use IPA wipes to clean the thermal grease from the heat sink and processor chip.

Before cleaning:



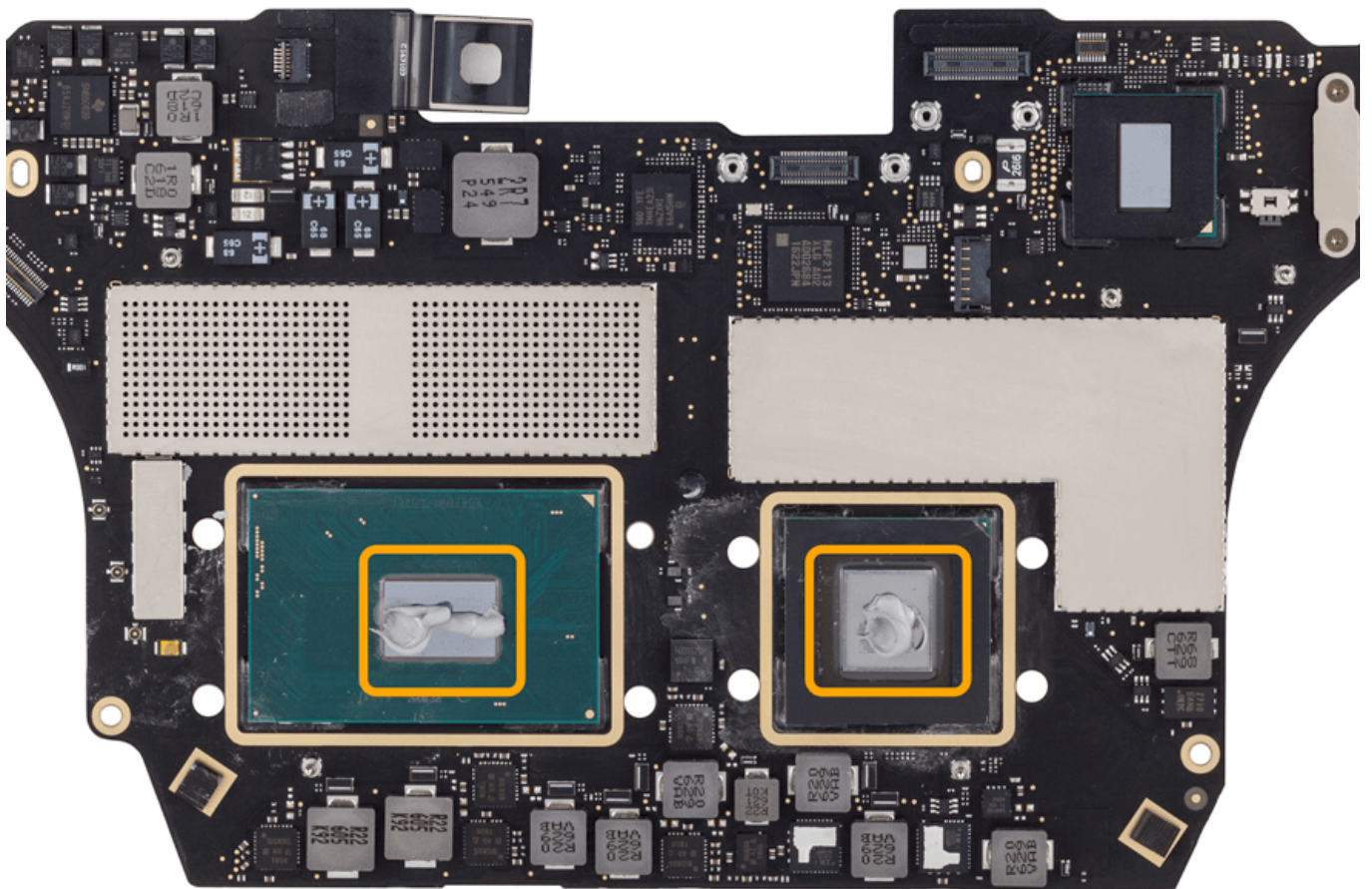
After cleaning:



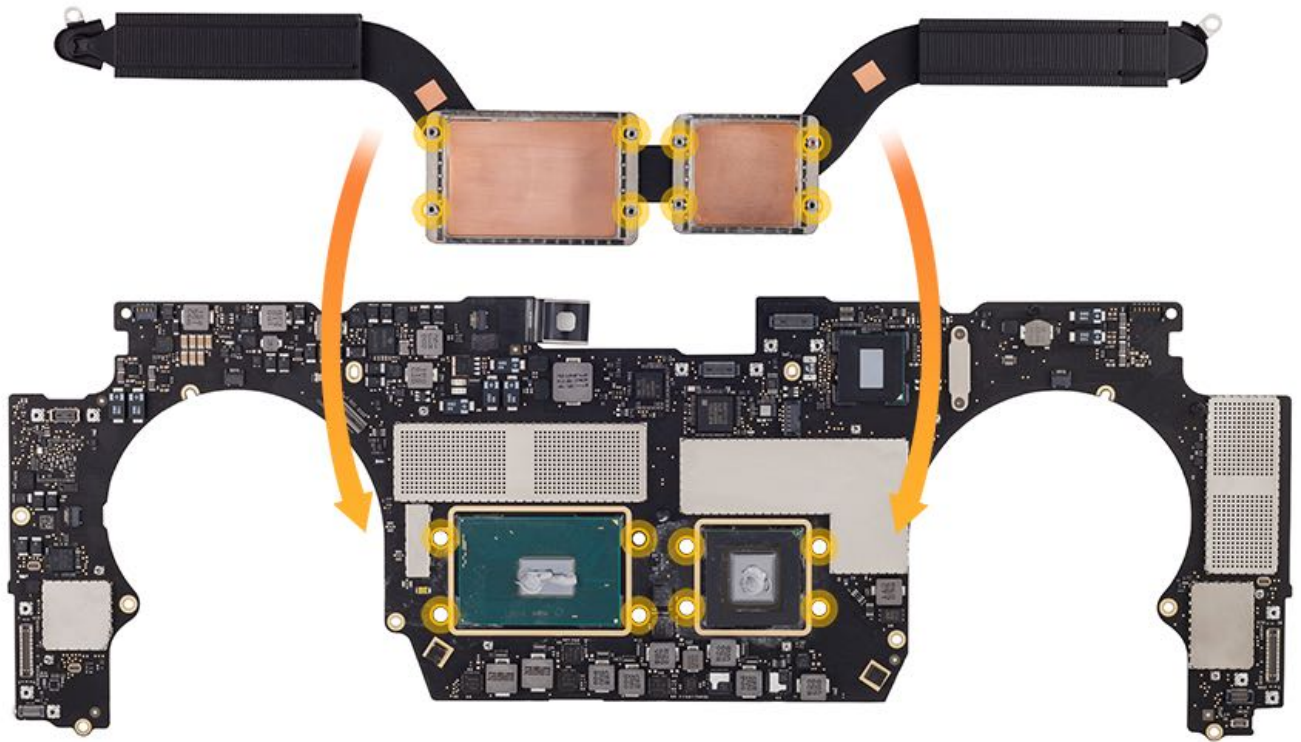
Steps For Reassembly

Note: Before ordering a replacement heat sink for MacBook Pro (15-inch, 2018 and 2019), refer to [TP1721: Repair Requirements based on Graphics Configuration](#) to find out how to determine the correct part number.

1. Use the thermal paste syringe to inject half of the paste on each processor chip.



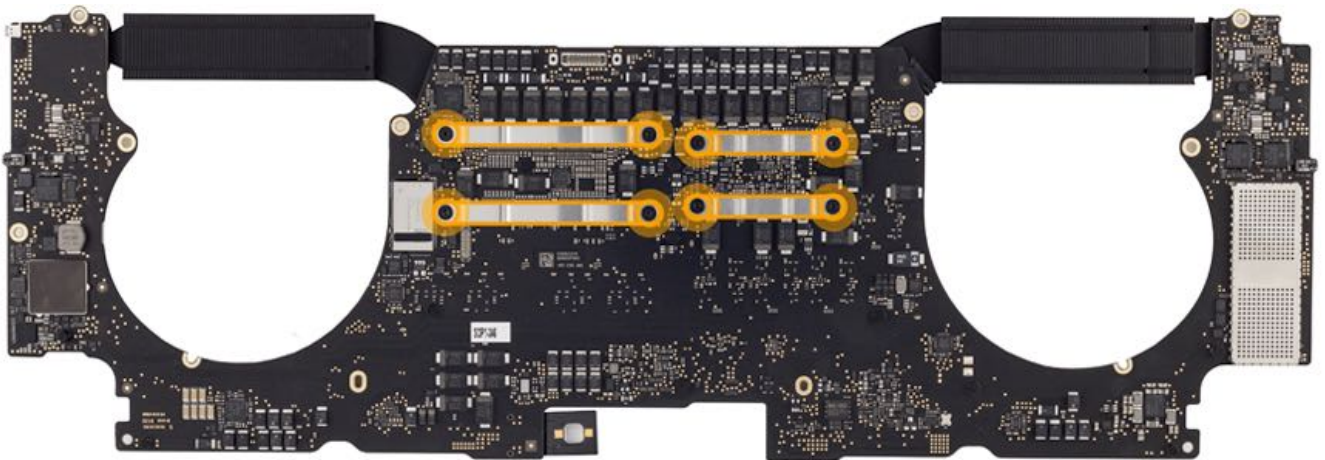
2. Carefully align the heat sink screw bosses with the screw holes on the logic board. Hold the heat sink in place as you carefully turn over the logic board to reinstall the screws.



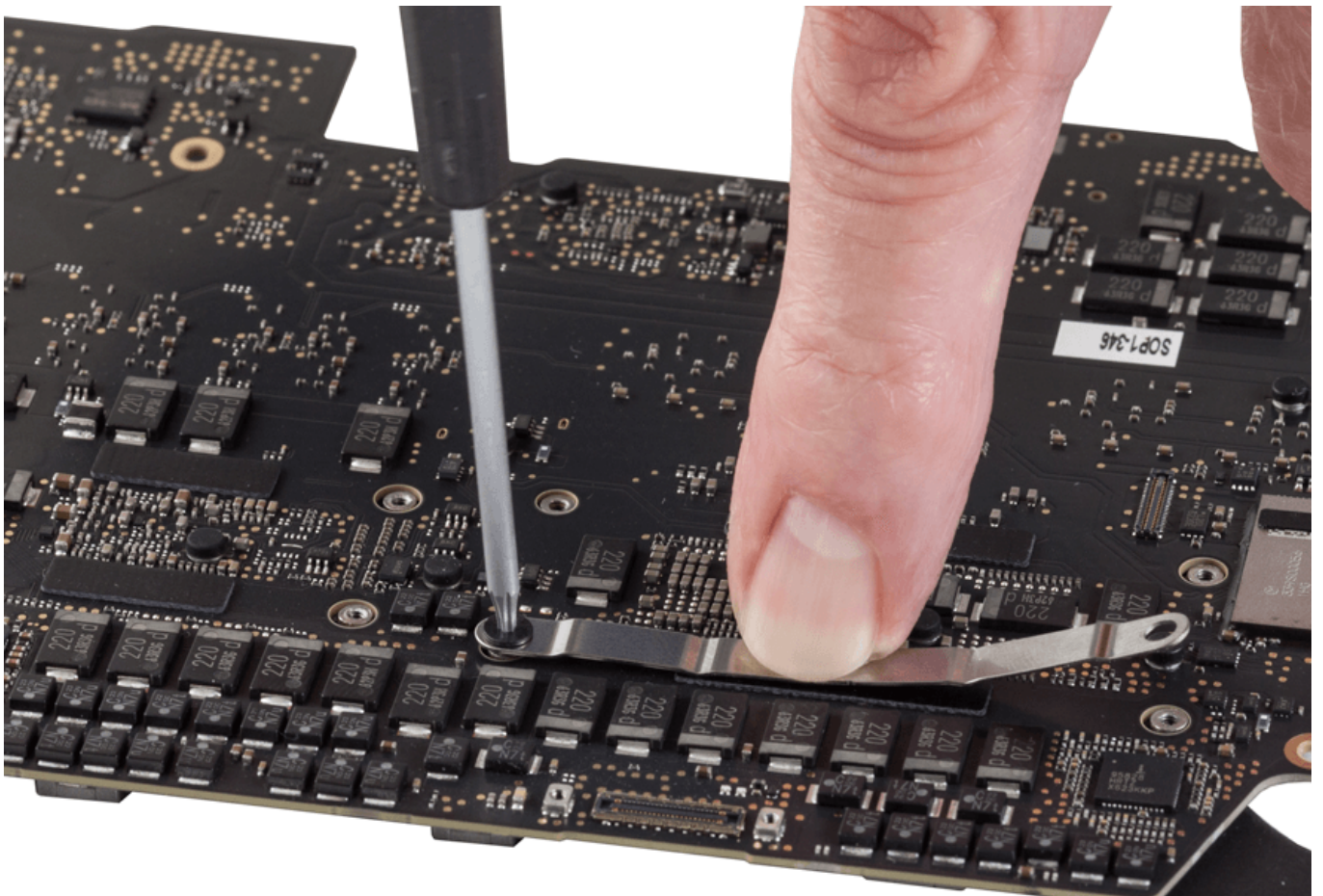
3. Reinstall the heat sink flexures and eight T5 heat sink screws.

Note:

- There are two sizes of flexures. Be sure to reinstall each one in the correct location.



- The heat sink flexures are under tension. Gently hold down the flexure when replacing the second screw on each flexure clip.



4. Reinstall the [logic board](#).
5. Reinstall the [clutch covers](#).
6. Reinstall the [BMU screw, reconnect the battery, and remove the battery cover](#).
7. Reinstall the [bottom case](#).
8. Follow the instructions in [TP1314: Trackpad Calibration Check](#) to verify the trackpad performance after every repair.

Embedded DisplayPort (eDP) Flex Cable

First Steps



Warning:

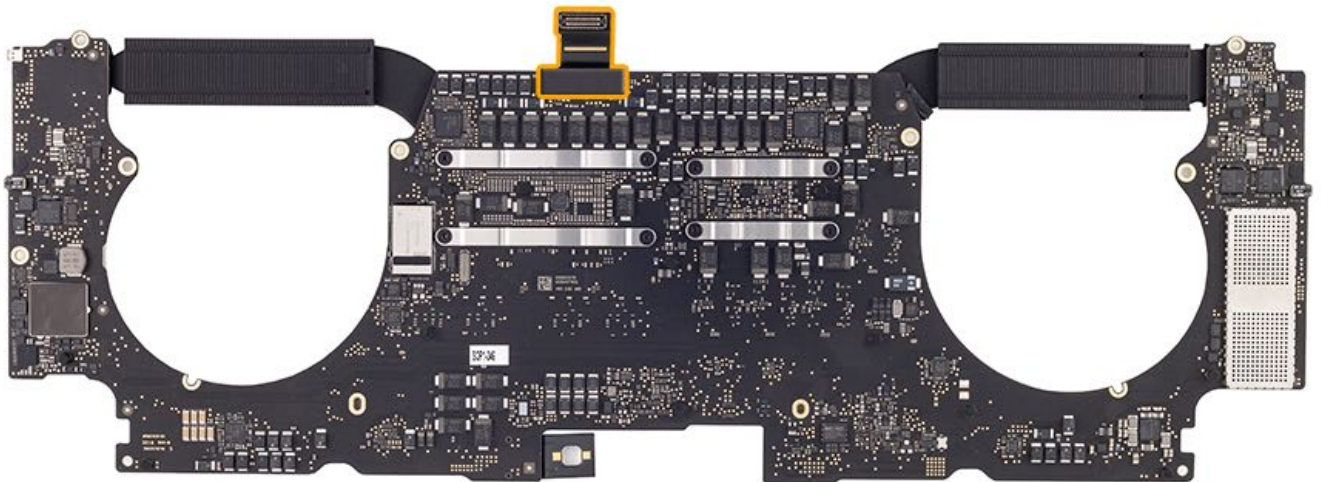
- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

Important:

- Only Apple-certified technicians should perform this procedure. For more information, refer to [OP1859: About Apple service certifications](#).
- Wear an ESD wrist strap and take precautions to avoid ESD.

Remove:

- [Bottom case](#)
- [Attach battery cover and disconnect battery](#)
- [Clutch covers](#)
- [Logic board](#)



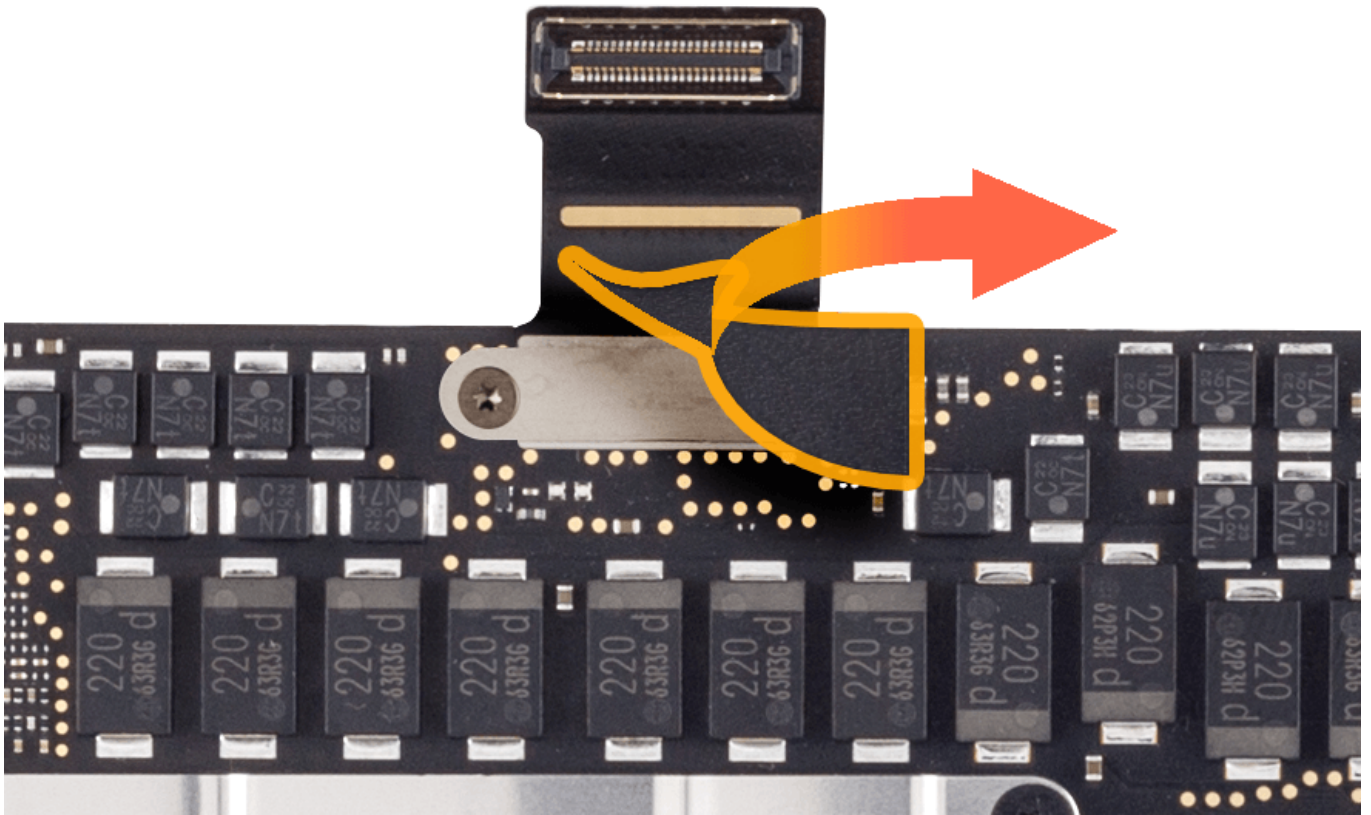
Tools

- Torx T3 screwdriver
- Black stick



Steps For Removal

1. Turn the logic board over.
2. Peel off the Mylar cover, if present.



3. Remove two T3 screws from the eDP flex cable cowling.

- T3: 923-01190



4. Use a black stick to disconnect the eDP flex cable from the logic board.

Steps For Reassembly

1. Reassemble in reverse order of removal steps.
2. Be sure to replace the Mylar that was peeled off with new Mylar if it is included with the part.
3. Reinstall the [logic board](#).
4. Reinstall the [clutch covers](#).
5. Reinstall the [BMU screw, reconnect the battery, and remove the battery cover](#).
6. Reinstall the [bottom case](#).
7. Follow the instructions in [TP1314: Trackpad Calibration Check](#) to verify the trackpad performance after every repair.

Vent/Antenna Assembly

First Steps



Warning:

- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

Important:

- Only Apple-certified technicians should perform this procedure. For more information, refer to [OP1859: About Apple service certifications](#).
- Wear an ESD wrist strap and take precautions to avoid ESD.

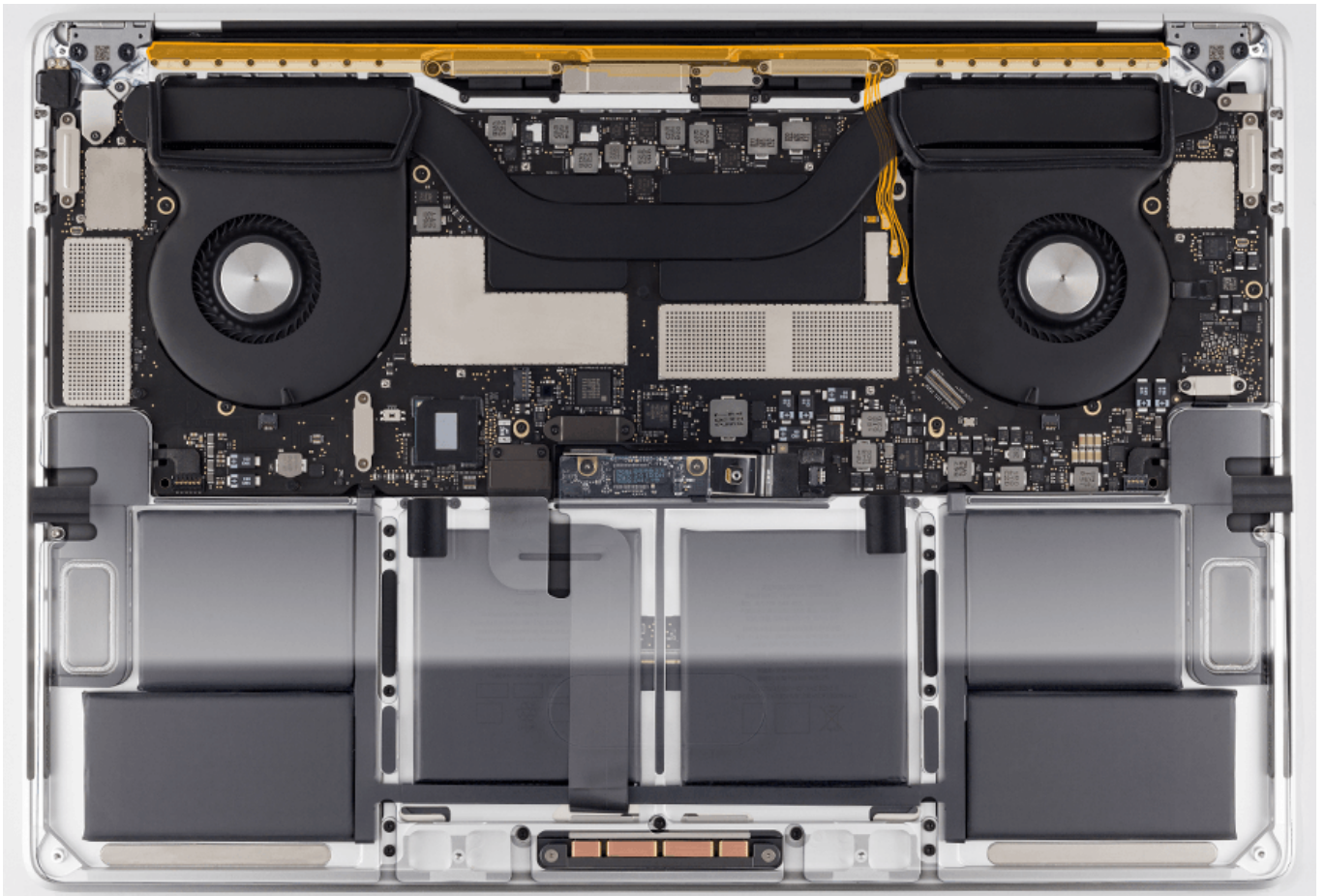
Remove:

- [Bottom case](#)
- [Attach battery cover and disconnect battery](#)
- [Clutch covers](#)

For video instruction, refer to [SV309: Vent/Antenna Module Replacement Video](#).

To get a better idea of what you are removing/replacing, see the image of the vent/antenna module below:





Tools

- Antenna removal tool, optional (923-01322)
- Black stick
- Torx T5 screwdriver (magnetized)
- Torque screwdriver (blue), 0.65kgf-cm (923-0448)
- Torx security bit (923-0247)
- ESD-safe plastic or nylon tweezers



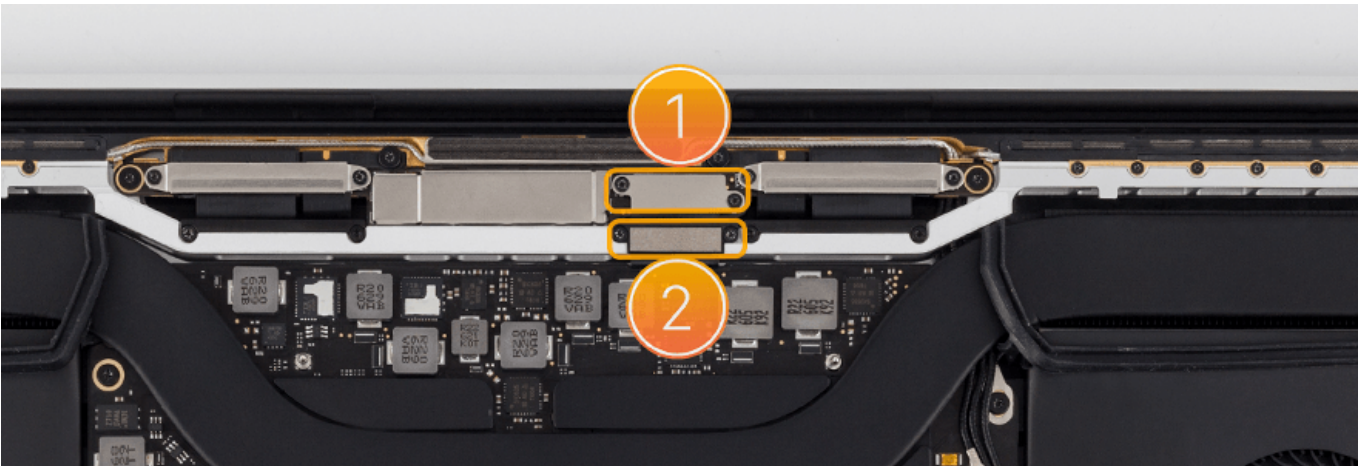
Steps For Removal

1. Remove the two T3 screws on the upper Embedded DisplayPort (eDP) flex cable cowling (1), the two T3 screws from the lower eDP flex cable cowling (2), and then disconnect the eDP flex cable.

- T3: 923-01285 (upper)



- T3: 923-01510 (lower)

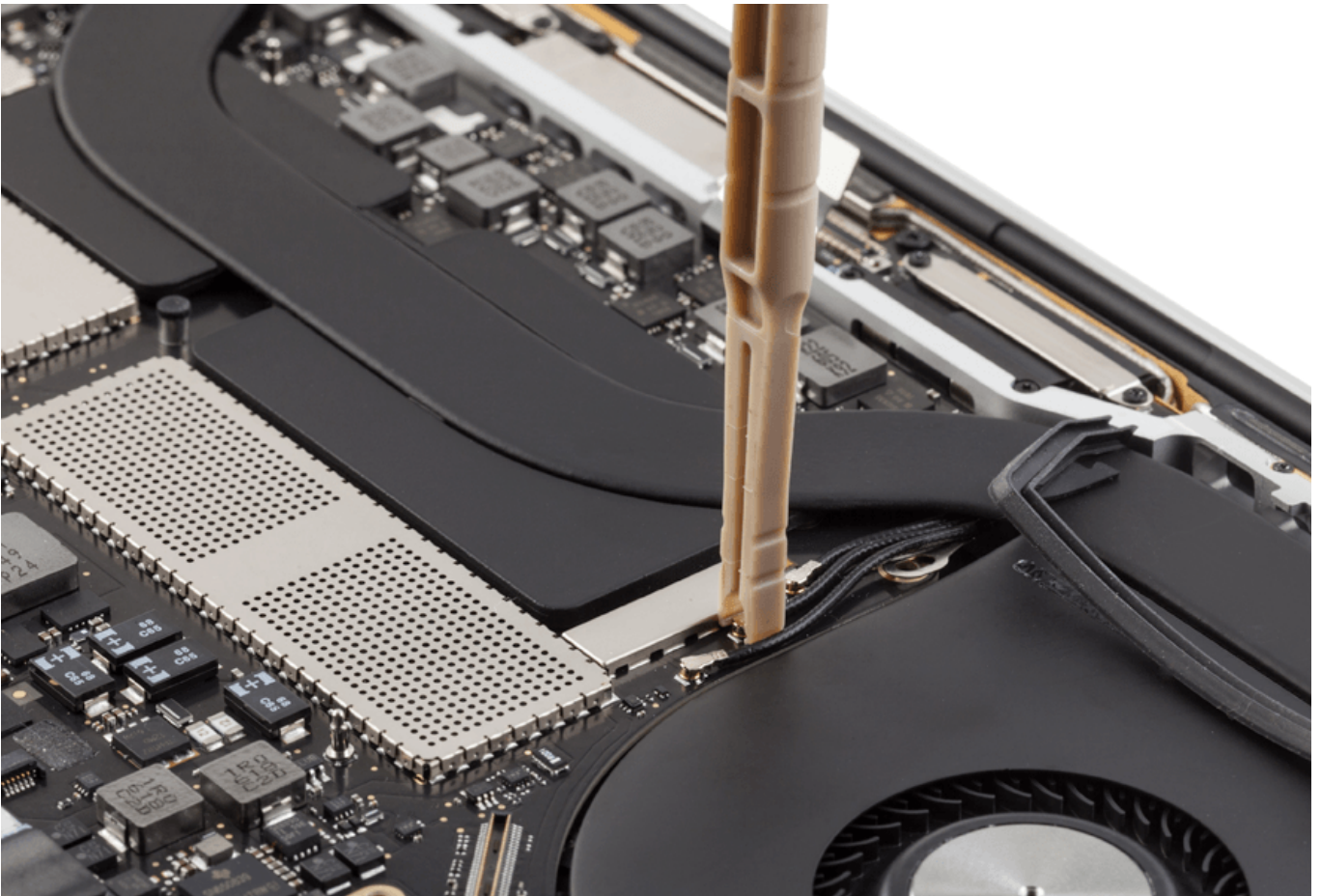


2. Remove the T5 antenna grounding screw from the logic board.

- T5: 923-01500



3. Use the antenna removal tool to disconnect the antenna cables from the logic board.

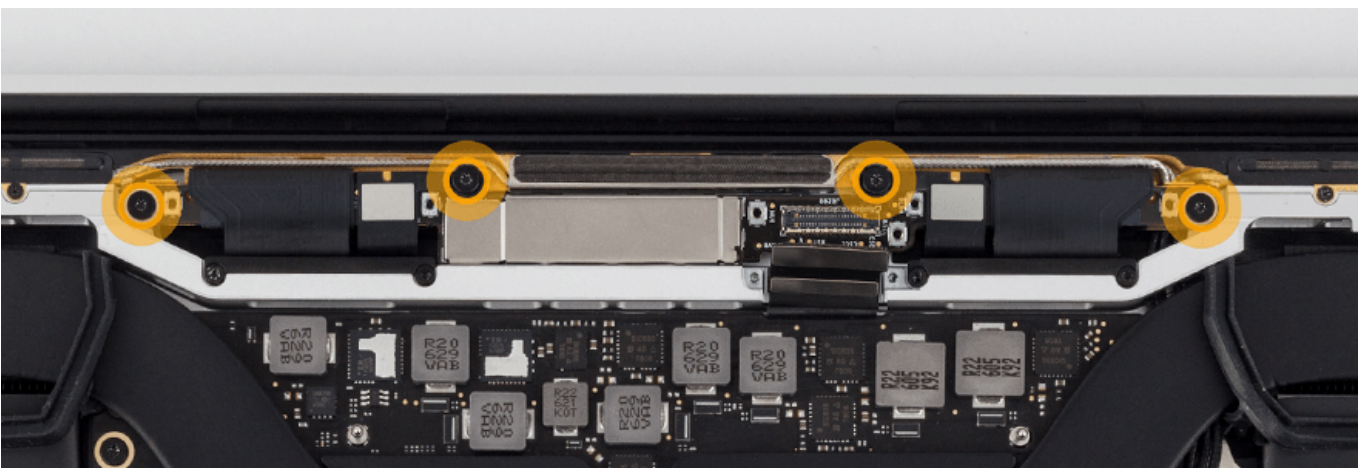


4. Remove the four T5 TCON screws.

- T5: 923-01277



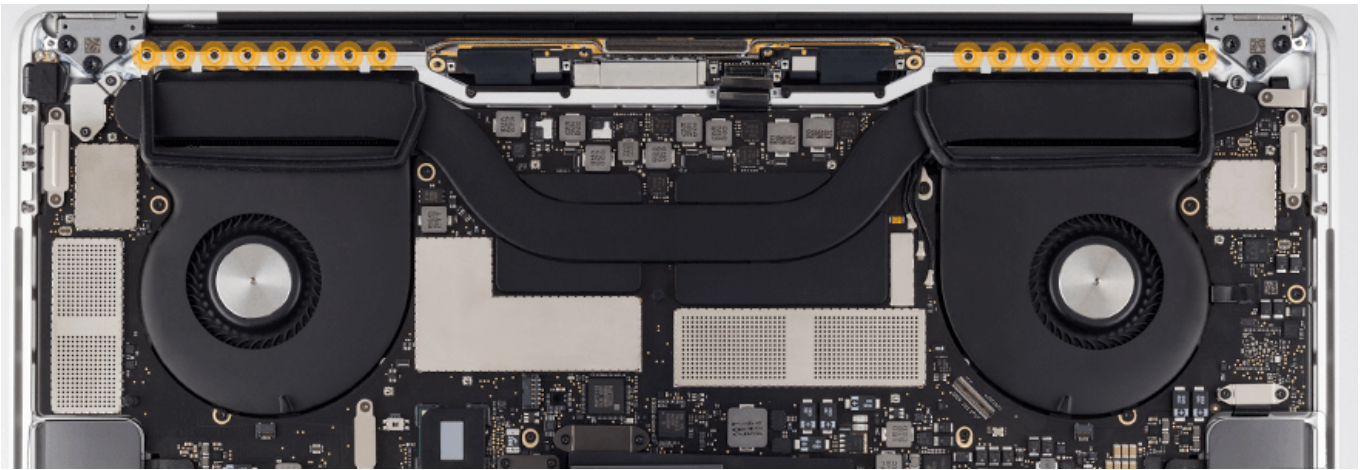
Note: The TCON board is part of the display assembly. Once the four TCON screws are removed, the TCON will release and the vent/antenna module can be accessed.



5. Remove the 16 1IPR vent/antenna screws with the torque screwdriver and Torx security bit. **Note:** Use a magnetized screwdriver to remove and reinstall the very small screws.

- 1IPR: 923-01512

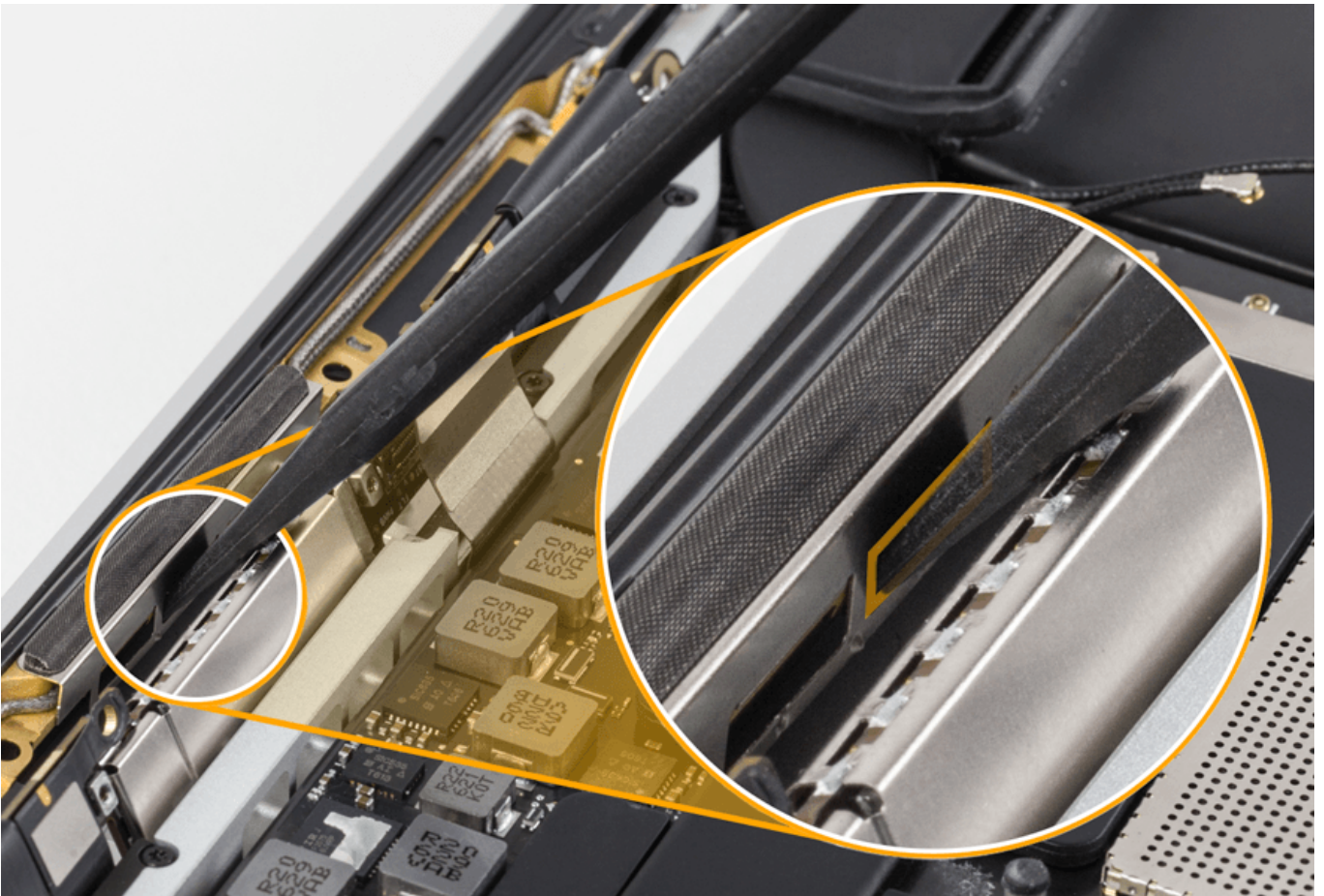




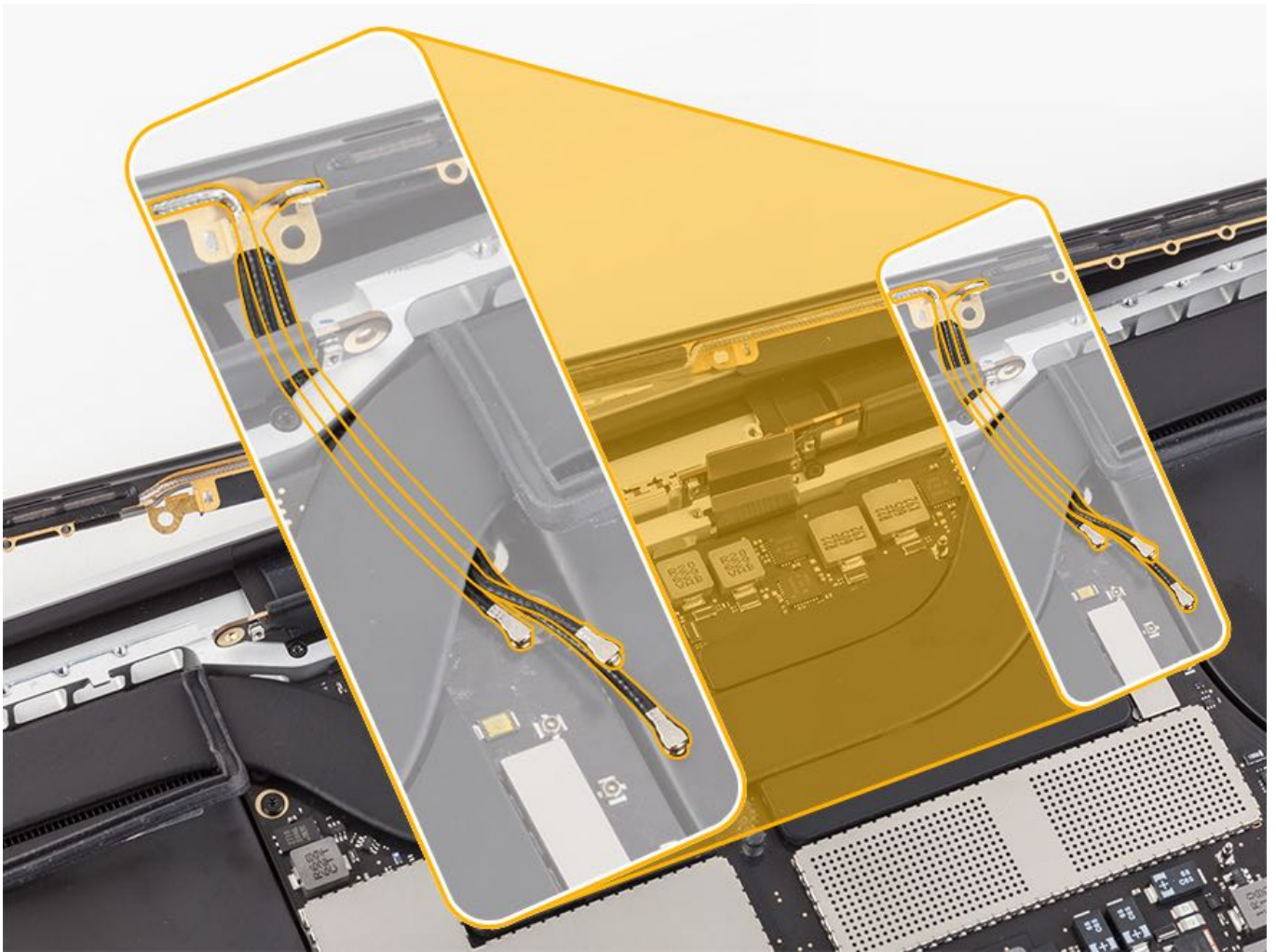
6. Find the middle slot in the vent/antenna module and gently insert the pointed end of a black stick in the slot to raise the vent/antenna module out of the top case. The vent/antenna module will make an audible click when released.

Caution:

- Be careful not to put pressure on the eDP flex cable.
- Support the vent/antenna module with your other hand to prevent it from bending as you take it out of the top case.



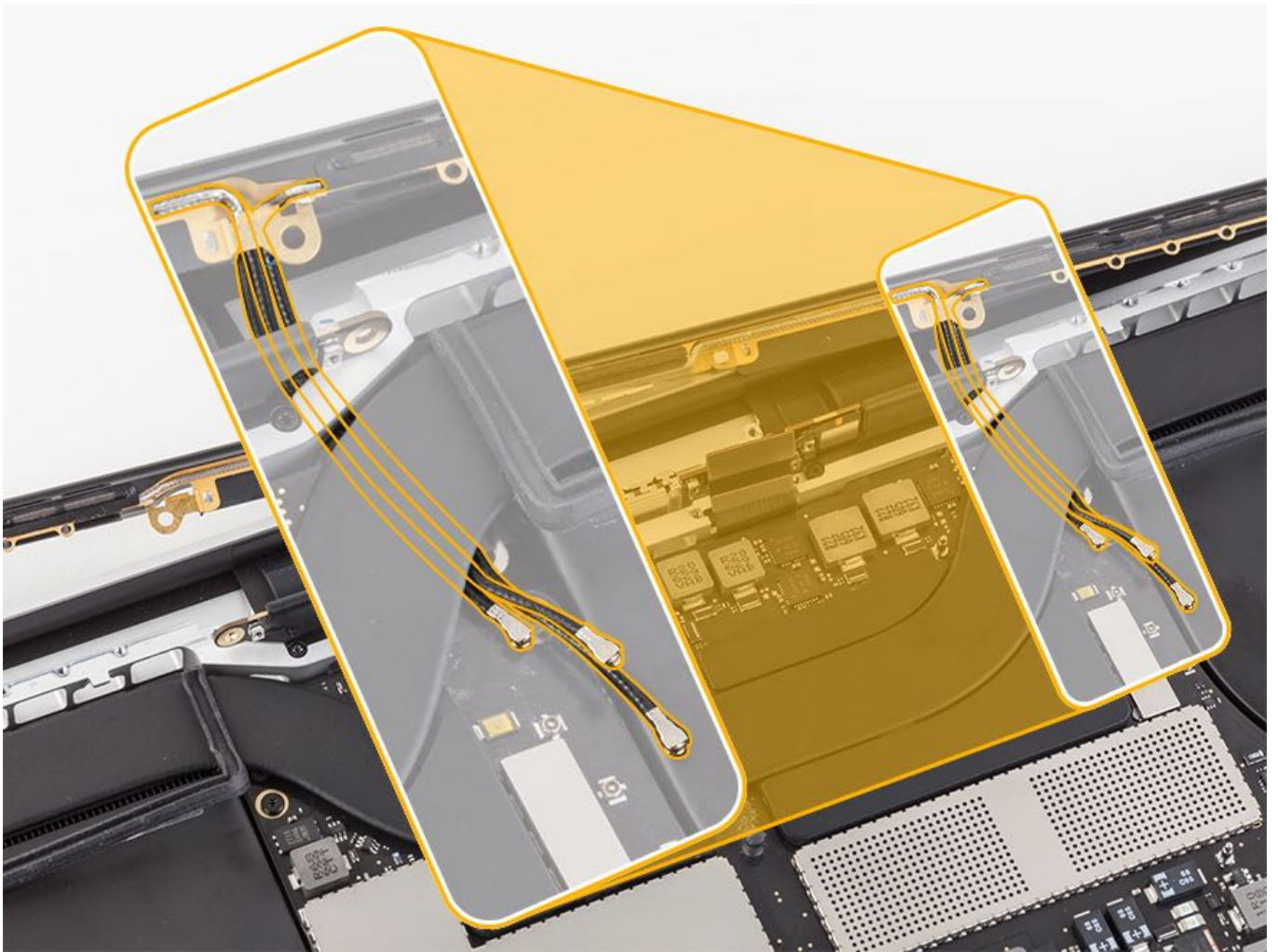
7. Route the antenna ground clip and three antennas through the opening in the rear wall. Be careful not to damage the wireless cables.



Steps For Reassembly

1. Use tweezers and/or black stick to route the three antennas and ground clip through the opening in the rear wall and over the logic board. Make sure the three cables are side by side, not overlapping.

Note: Some replacement vent/antenna modules include a removable sleeve to protect the antenna cables during shipment. The sleeve can stay on the cables while the cables are rerouted into the top case. However, remove the sleeve when the cables are positioned over the logic board.



2. Align the vent/antenna module in the top case and gently press down in the middle of the module until it makes an audible click.

3. Reconnect the antennas and reinstall the T5 antenna ground screw (923-01500).

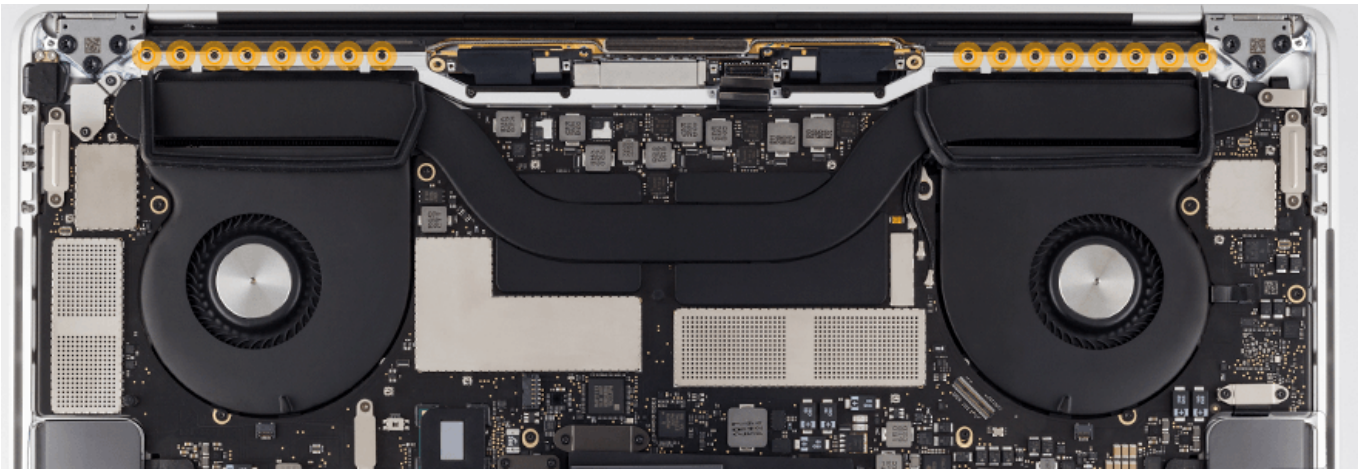
Note: When reconnecting the antennas, use tweezers to align the antenna head with the connector on the logic board. Then use the opposite side of the antenna removal tool to make the connection.



4. Reinstall the 16 1IPR vent/antenna screws (923-01512) with the torque screwdriver and Torx security bit.

Note: Use a magnetized screwdriver to remove and reinstall the very small screws.

Note: Turn each screw until the torque screwdriver clicks (applies the correct torque). Some screws may seat properly without an audible click. Do not overtighten the screws.



5. Then reassemble in reverse order of removal steps.
6. Reinstall the [clutch covers](#).
7. Reinstall the [BMU screw, reconnect the battery, and remove the battery cover](#).
8. Reinstall the [bottom case](#).
9. Follow the instructions in [TP1314: Trackpad Calibration Check](#) to verify the trackpad performance after every repair.

Fans

First Steps



Warning:

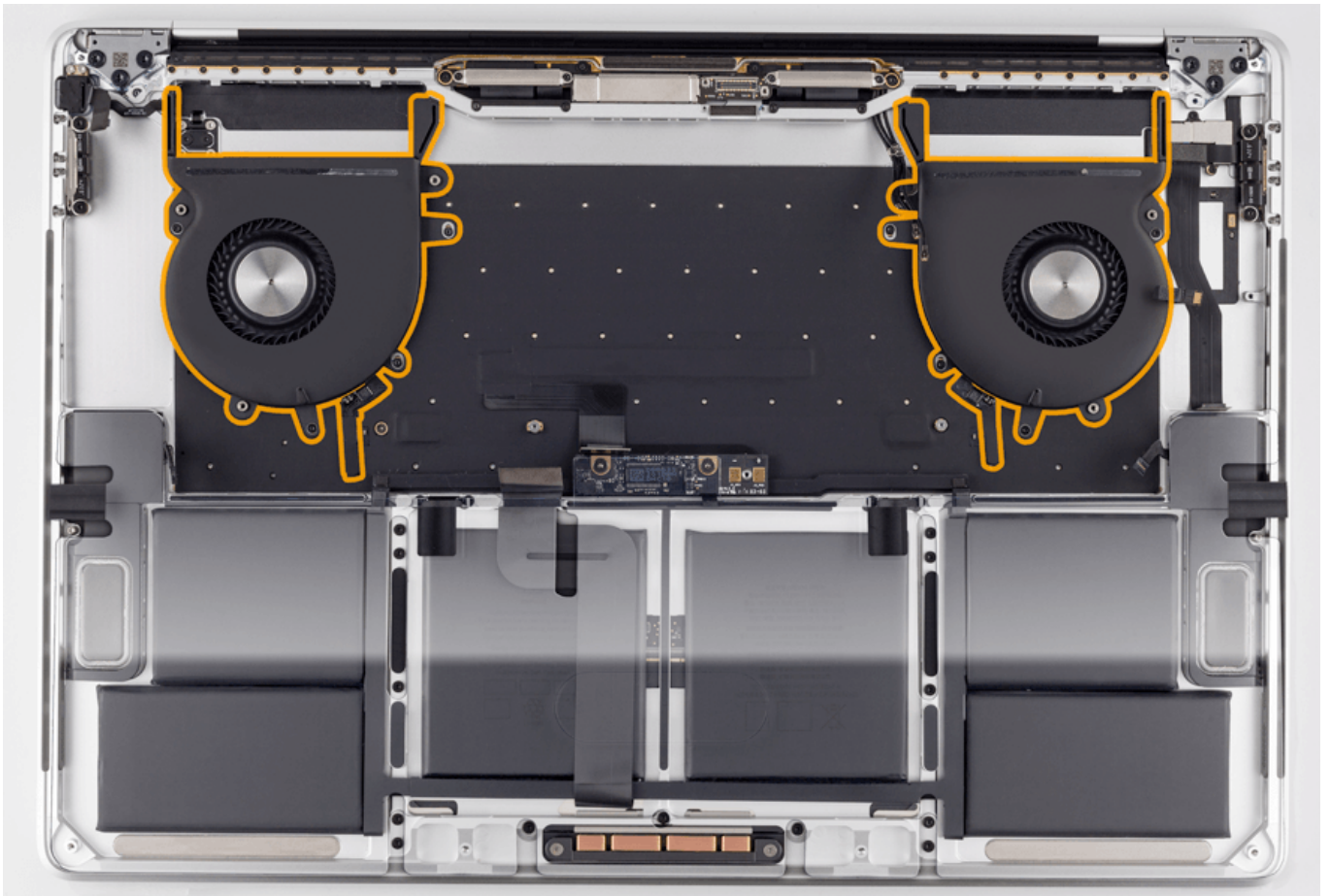
- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

Important:

- Only Apple-certified technicians should perform this procedure. For more information, refer to [OP1859: About Apple service certifications](#).
- Wear an ESD wrist strap and take precautions to avoid ESD.

Remove:

- [Bottom case](#)
- [Attach battery cover and disconnect battery](#)
- [Clutch covers](#)
- [Logic board](#)



Note: The left and right fans can be replaced separately. They do not have to be replaced as a pair. The procedure is the same for both.

Tools

- Torx T3 screwdriver (magnetized)
- Black stick



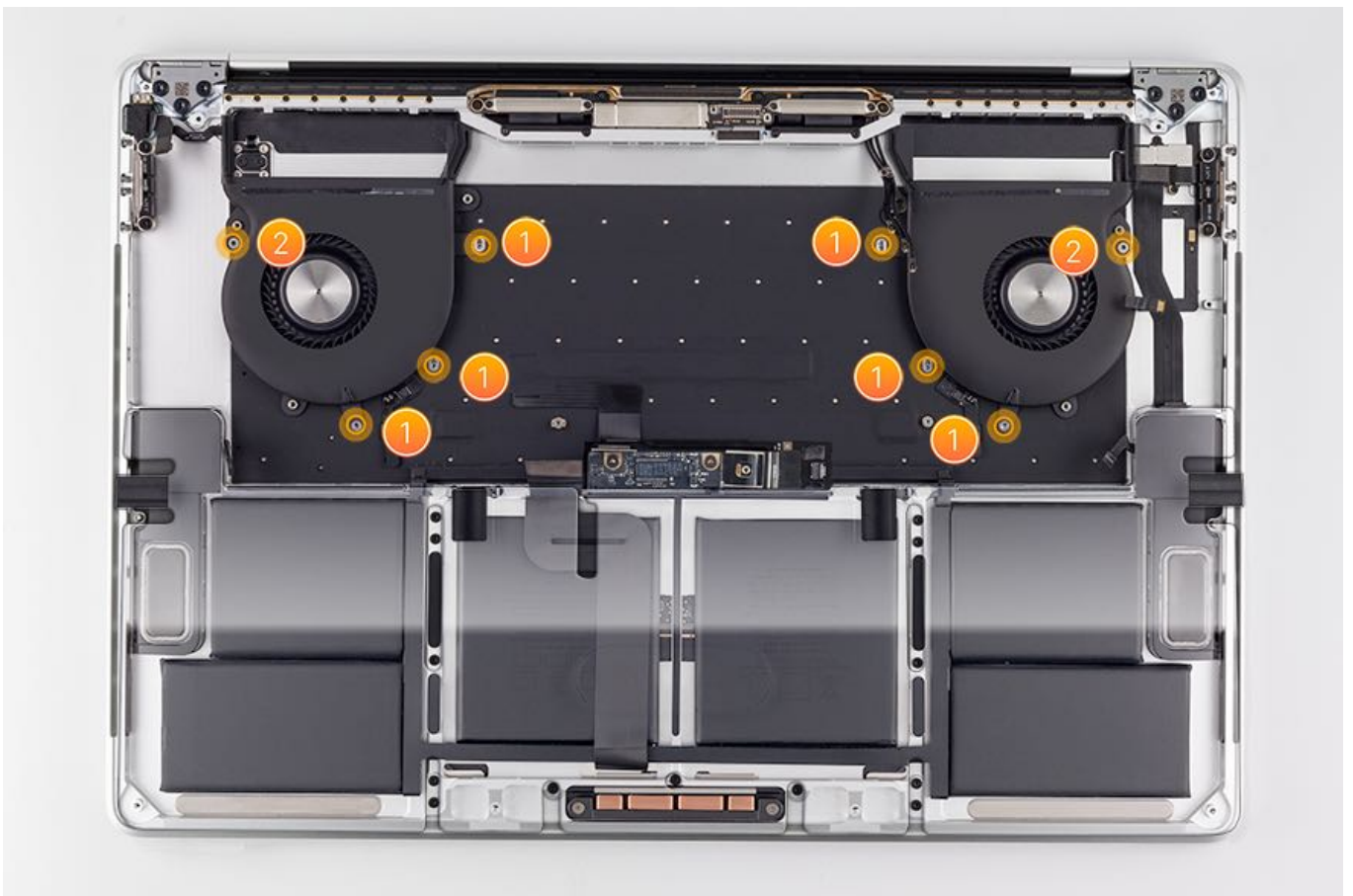
Steps For Removal

1. If removing one fan, remove three black T3 fan screws (1) and one silver T3 screw (2). If removing both fans, remove six black T3 fan screws (1) and two silver T3 screws (2).

- T3: 923-01423 (position 1)



- T3: 923-01515 (position 2)



2. Peel the Mylar cover off the fan flex cable.



3. Lift the locking lever and use tweezers to carefully disconnect the flex cable.



Steps For Reassembly

1. Place the fan in the top case, reconnect the flex cable, and tape down the Mylar.

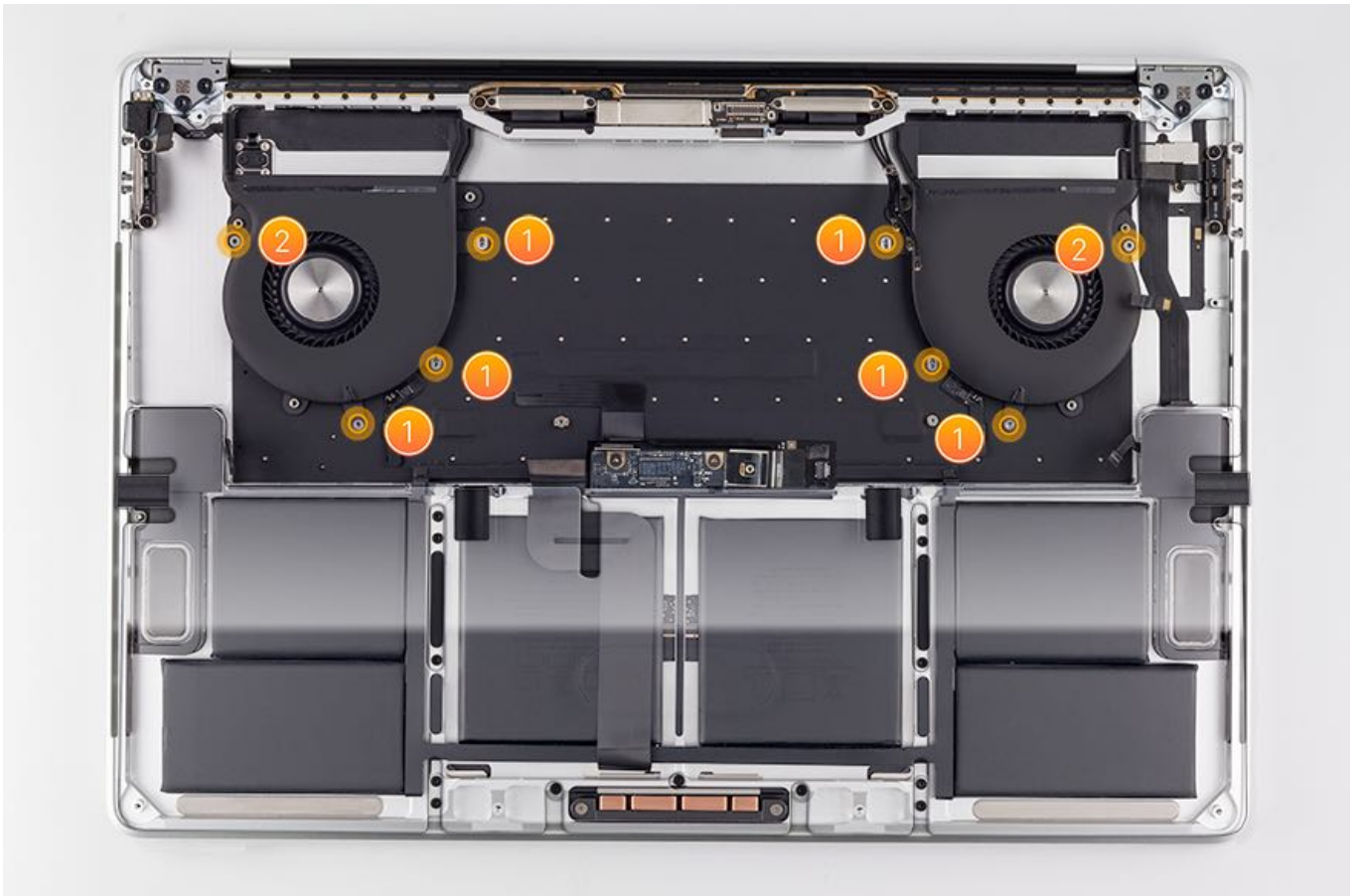
2. Carefully align the screw holes and the screw bosses.

Note: It may help to torque screws halfway first to make sure all four screws are aligned correctly, and then go back and tighten screws.

- T3: 923-01423 (position 1)



- T3: 923-01515 (position 2)



3. Reinstall the [logic board](#).

4. Reinstall the [clutch covers](#).

5. Reinstall the [BMU screw, reconnect the battery, and remove the battery cover](#).

6. Reinstall the [bottom case](#).

7. Follow the instructions in [TP1314: Trackpad Calibration Check](#) to verify the trackpad performance after every repair.

Input/Output (I/O) Boards

First Steps



Warning:

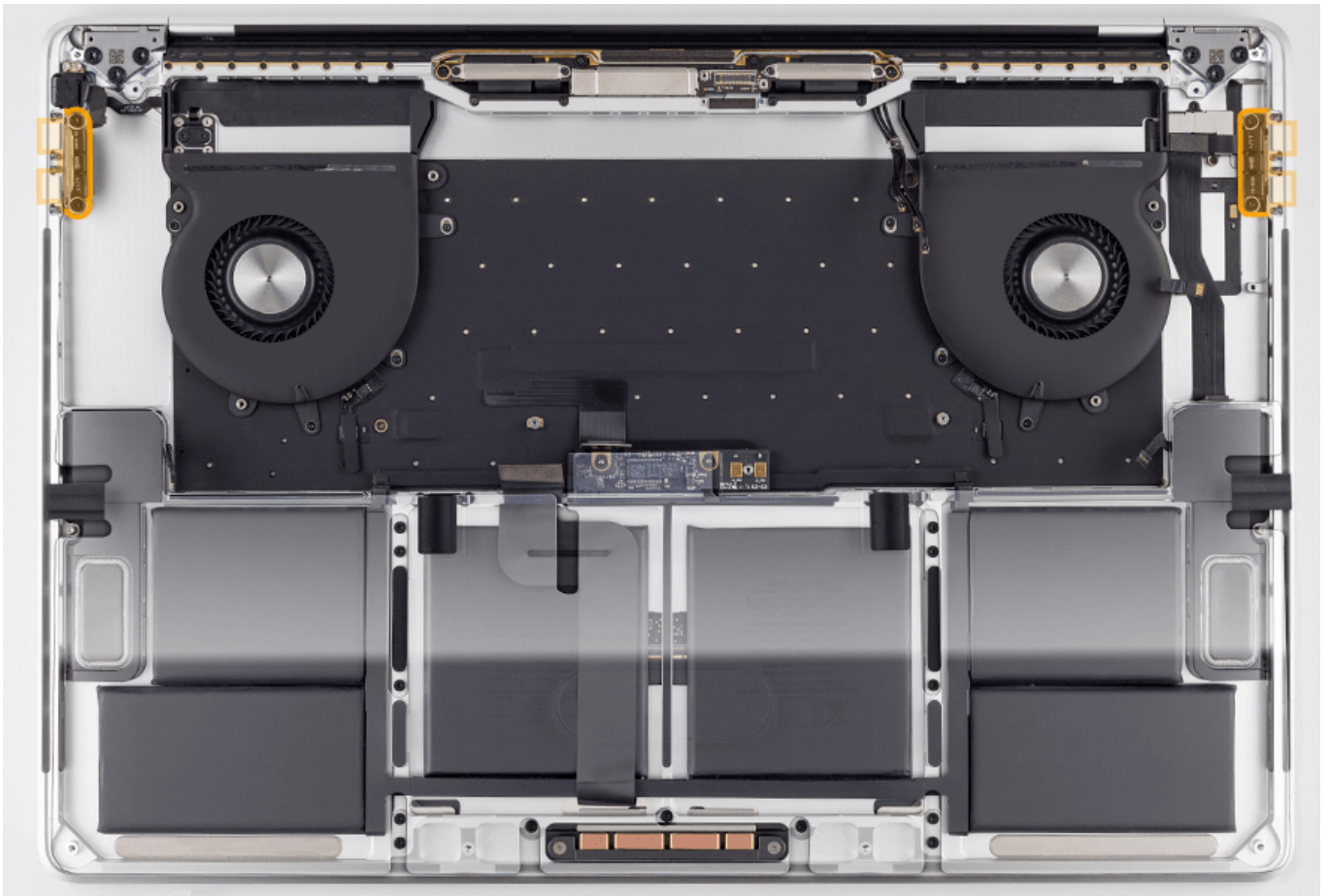
- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

Important:

- Only Apple-certified technicians should perform this procedure. For more information, refer to [OP1859: About Apple service certifications](#).
- Wear an ESD wrist strap and take precautions to avoid ESD.

Remove:

- [Bottom case](#)
- [Attach battery cover and disconnect battery](#)
- [Clutch covers](#)
- [Logic board](#)



Tools

- Torx T5 screwdriver (magnetized)
- Black stick



Steps For Removal

1. For MacBook Pro (15-inch, 2018 and 2019) only: Remove two T3 screws from the cowling and remove cowling.

- T3: 923-02513



2. Remove two T5 screws from the USB-C board.

- T5: 923-01509

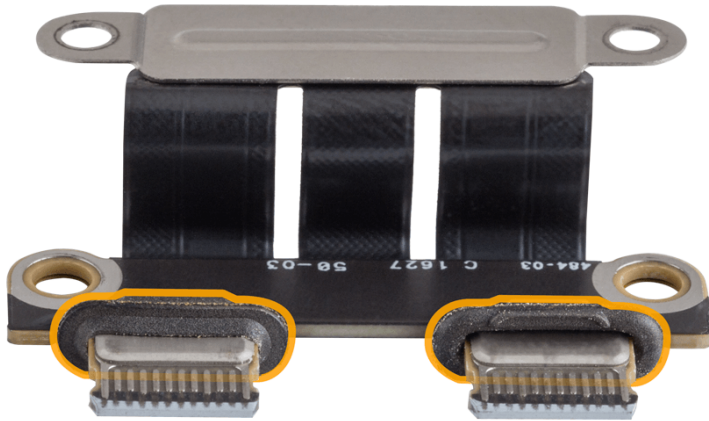


3. Grasp the board by the sides and gently slide it out of the ports.



Steps For Reassembly

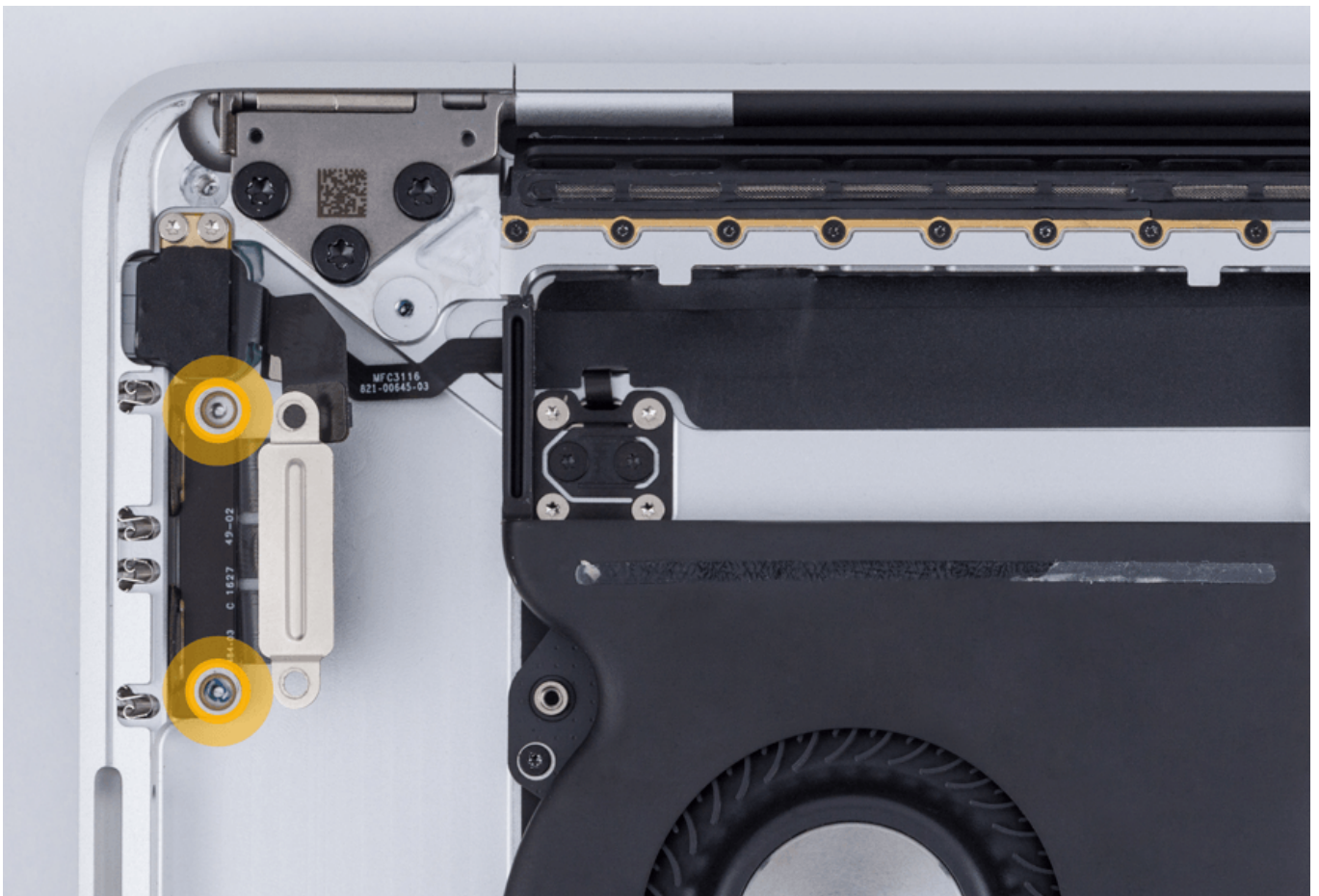
Note: Before reinstalling the left or right I/O board, check to make sure the rubber gaskets are undamaged and intact. If they are not, the I/O board will need to be replaced. Gaskets are not present on MacBook Pro (15-inch, 2018 and 2019).



1. After placing the board into position in the top case, plug an external USB-C charging cable into both Thunderbolt 3 ports.
Warning: The charging cable should **not** be plugged into power.



2. Keeping the cable connected, check that the screw holes in the board align with the screw bosses in the top case. Reinstall the two T5 screws.



3. For MacBook Pro (15-inch, 2018 and 2019), reinstall the cowling and two T3 screws.
4. Reinstall the [logic board](#).
5. Reinstall the [clutch covers](#).
6. Reinstall the [BMU screw, reconnect the battery, and remove the battery cover](#).
7. Reinstall the [bottom case](#).
8. Follow the instructions in [TP1314: Trackpad Calibration Check](#) to verify the trackpad performance after every repair.

Display Assembly

First Steps



Warning:

- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

Important:

- Only Apple-certified technicians should perform this procedure. For more information, refer to [OP1859: About Apple service certifications](#).
- Wear an ESD wrist strap and take precautions to avoid ESD.

Caution:

- For MacBook Pro (2018 and 2019) this repair is not complete until System Configuration has been performed. For instructions, refer to [TP1657: System Configuration for Macs with the Apple T2 Security Chip](#).

Remove:

- [Bottom case](#)
- [Attach battery cover and disconnect battery](#)
- [Clutch covers](#)
- [Vent/antenna module](#)

For video instruction, refer to [SV310: Display Assembly Replacement Video](#).



Tools

- Torx T3 screwdriver

- Torx T8 screwdriver



Steps For Removal

1. Remove four T3 spring tensioner screws secured to the rear wall.

- T3: 923-01185



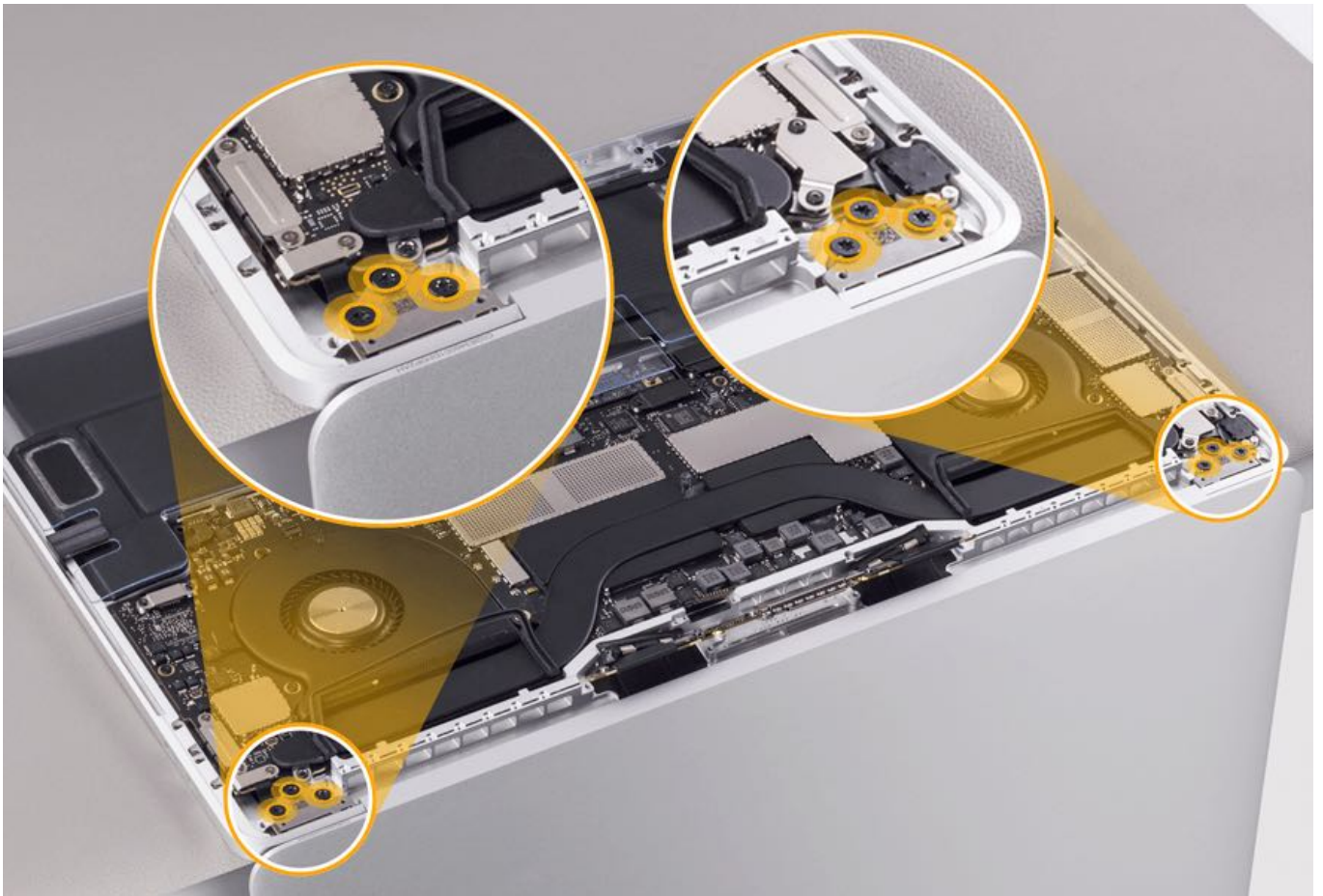
2. Open the display and place the computer on the edge of a workbench, with the display hanging down.



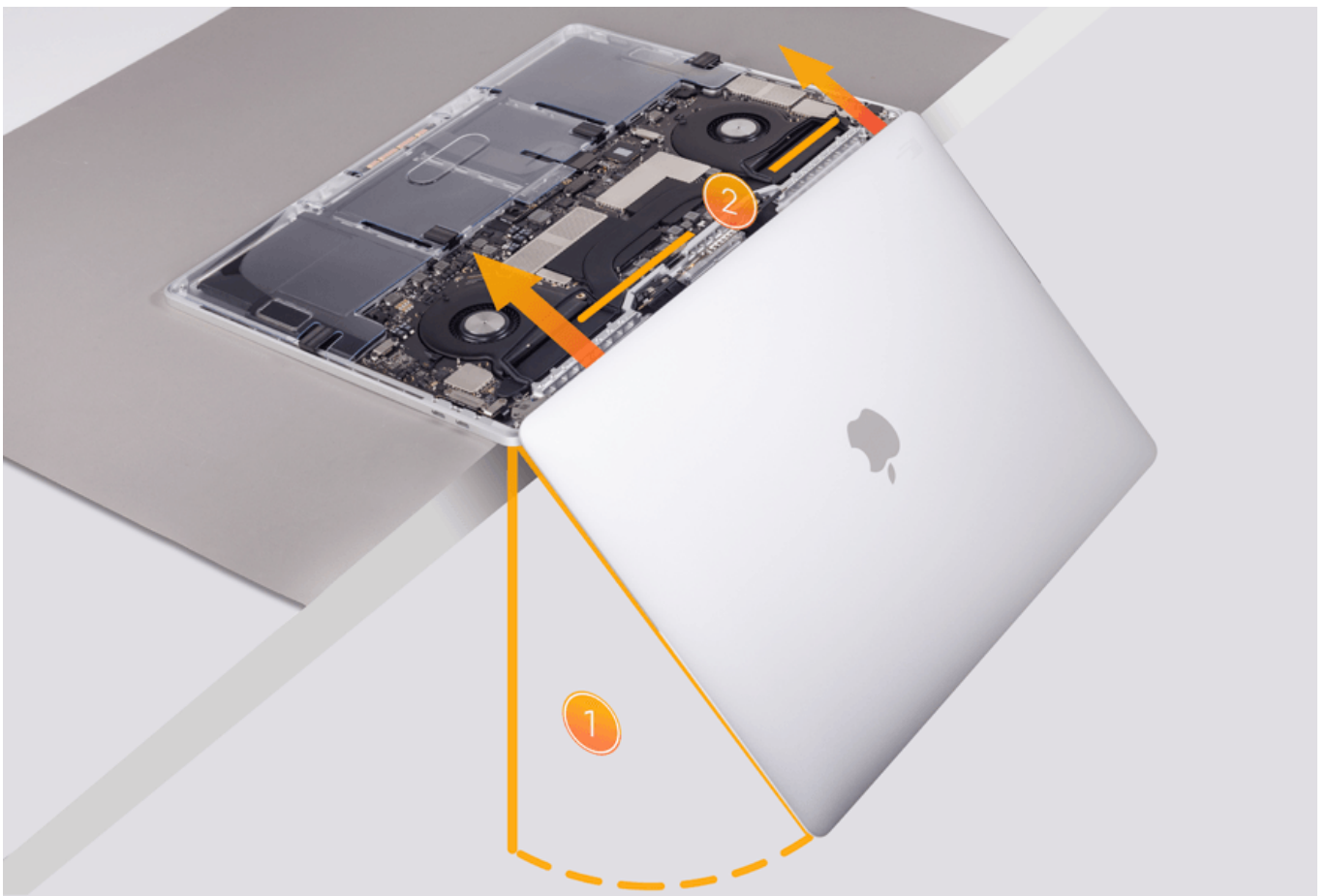
3. Remove six T8 display hinge screws.

- T8: 923-01173





4. Separate the display assembly from the top case. Pull the display toward you about 15 degrees (1), then lift the display up and off the top case (2).



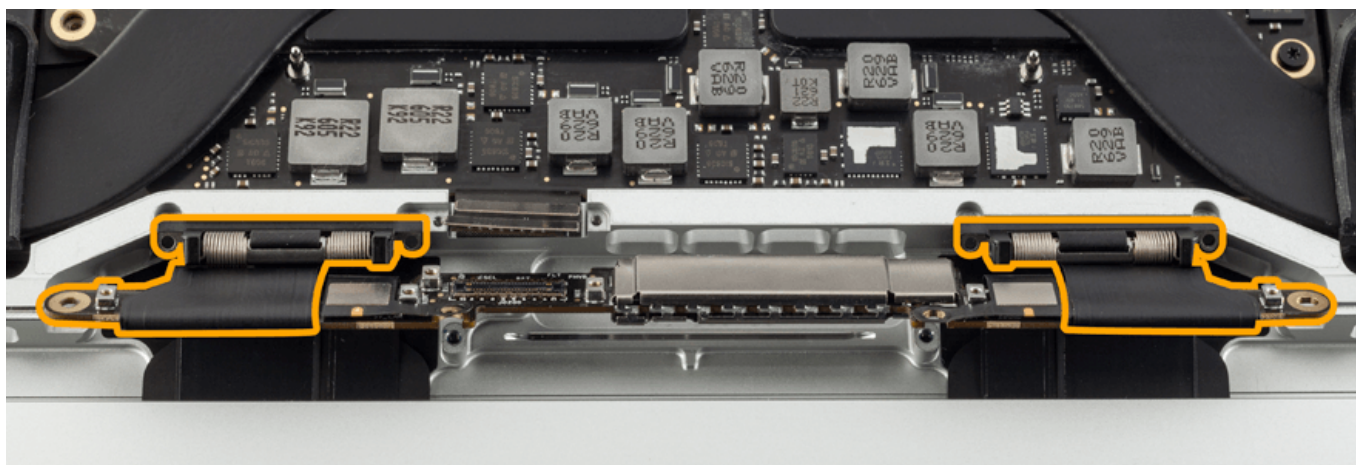
Steps For Reassembly

Caution: The display assembly includes the TCON board and the spring tensioners. Be careful not to damage these

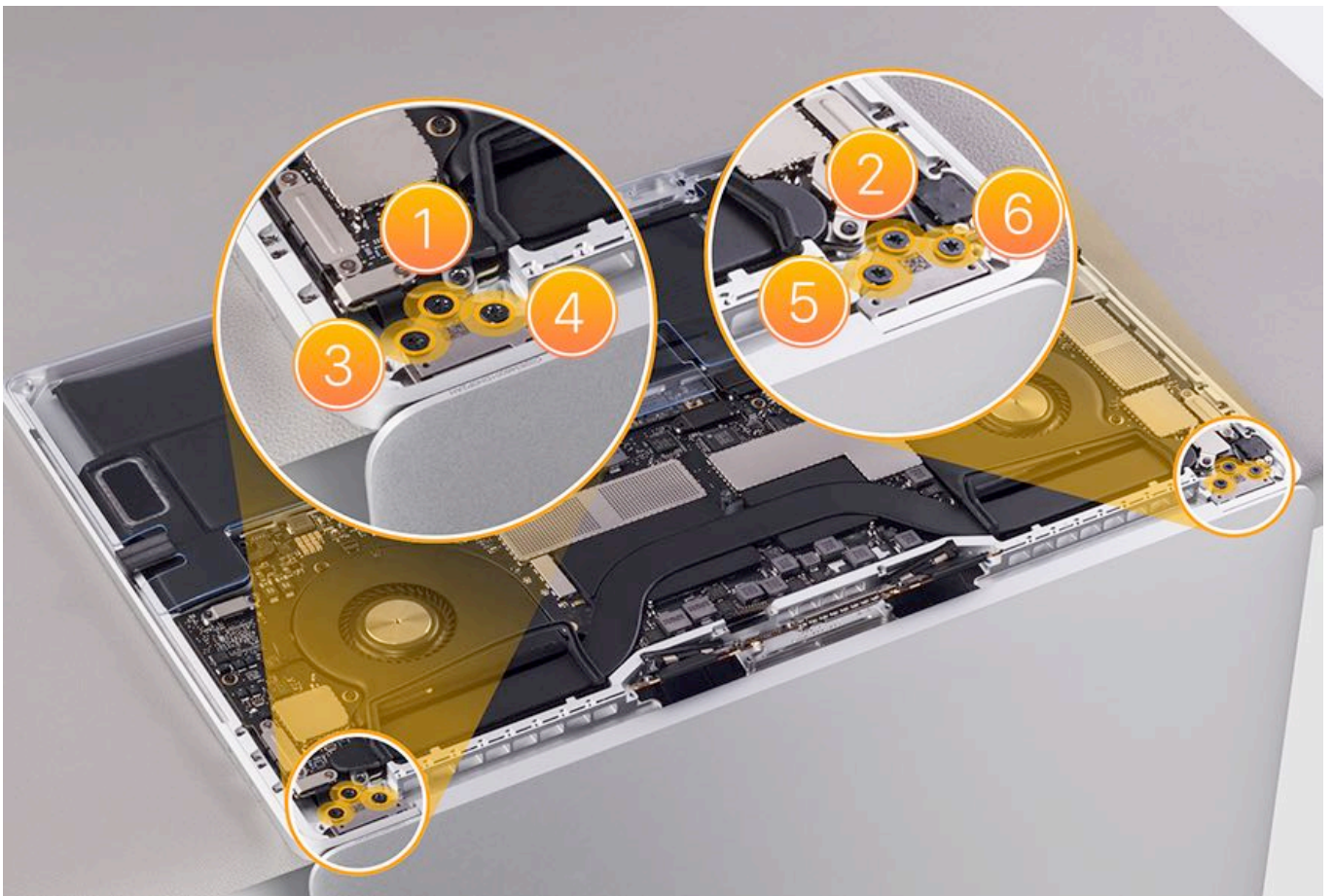
components when reinstalling the display assembly.



1. Reinstall the display onto the top case. Make sure that the TCON board and spring tensioners are positioned within the top case. If reassembled incorrectly, the TCON board and spring tensioners could get wedged between the top case and the display.



2. Loosely reinstall the six T8 display hinge screws (923-01173) in the order shown.



3. Close the computer, and adjust the display alignment to the top case by touch.

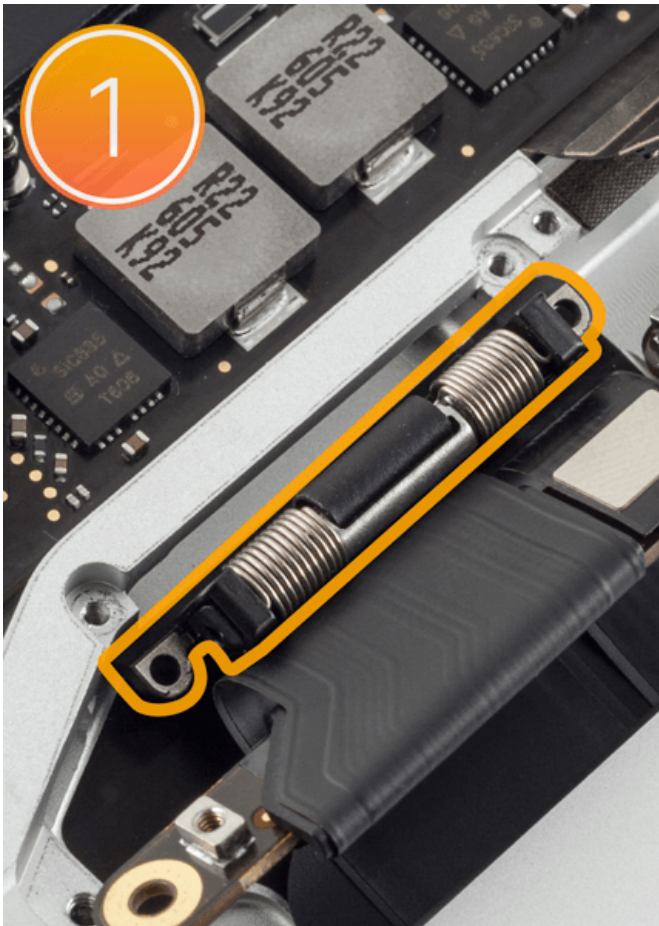


4. Stand up the computer on a clean, flat surface to level the front-to-rear clutch alignment.



5. Tighten all six T8 screws.

6. Roll the spring tensioners forward and align the screw holes on the spring tensioners with the screw holes on the rear wall. Reinstall the T3 screws (923-01185).



7. Reinstall the [vent/antenna module](#).

8. Reinstall the [clutch covers](#).
9. Reinstall the [BMU screw, reconnect the battery, and remove the battery cover](#).
10. Reinstall the [bottom case](#).



11. **Caution:** For MacBook Pro (2018 and 2019) this repair is not complete until the System Configuration has been performed. For instructions, refer to [TP1657: System Configuration for Macs with the Apple T2 Security Chip](#).
12. Follow the instructions in [TP1314: Trackpad Calibration Check](#) to verify the trackpad performance after every repair.

Keyboard Flex Cable

First Steps



Warning:

- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

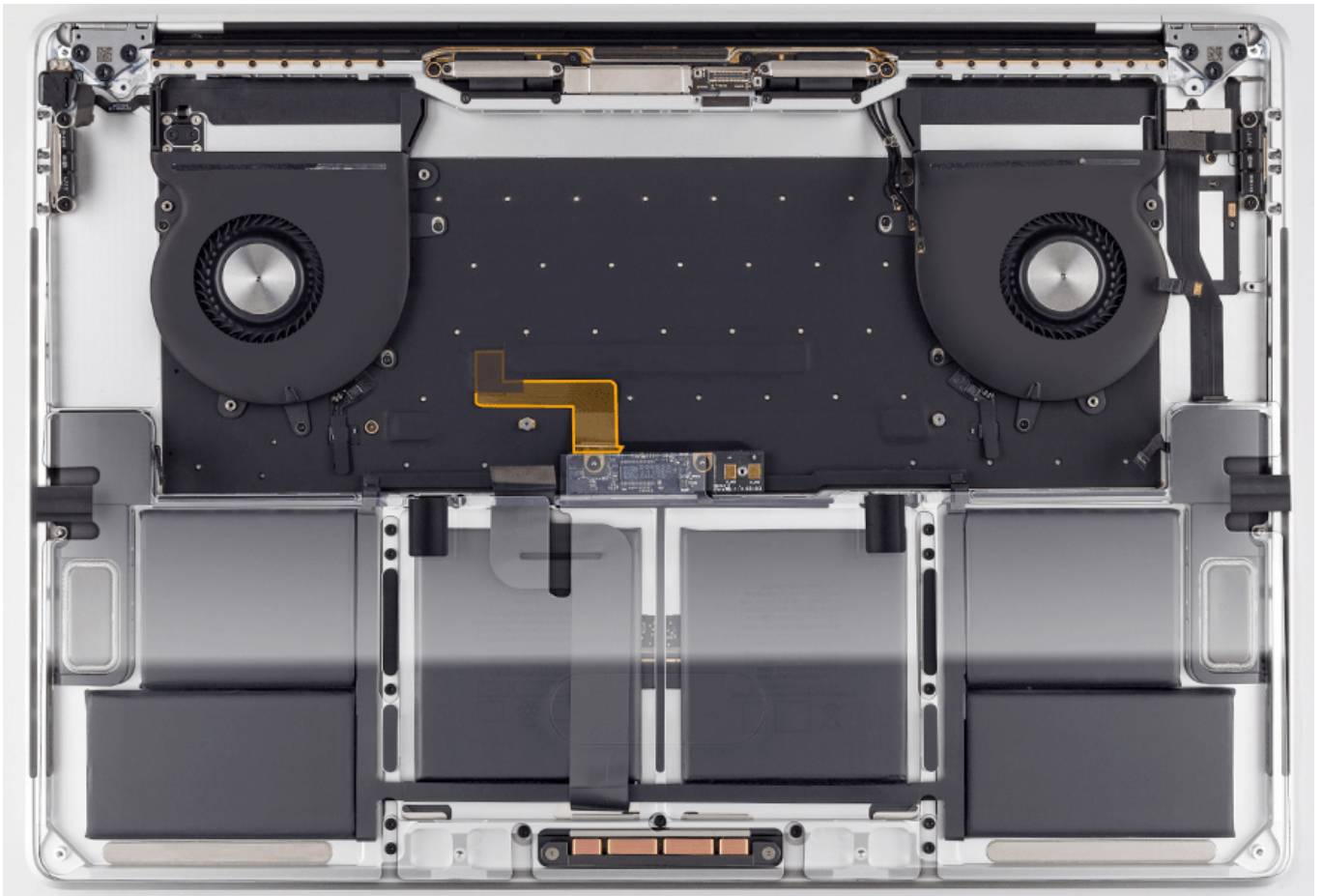
Important:

- Only Apple-certified technicians should perform this procedure. For more information, refer to [OP1859: About AppleCare service certifications](#).
- Wear an ESD wrist strap and take precautions to avoid ESD.

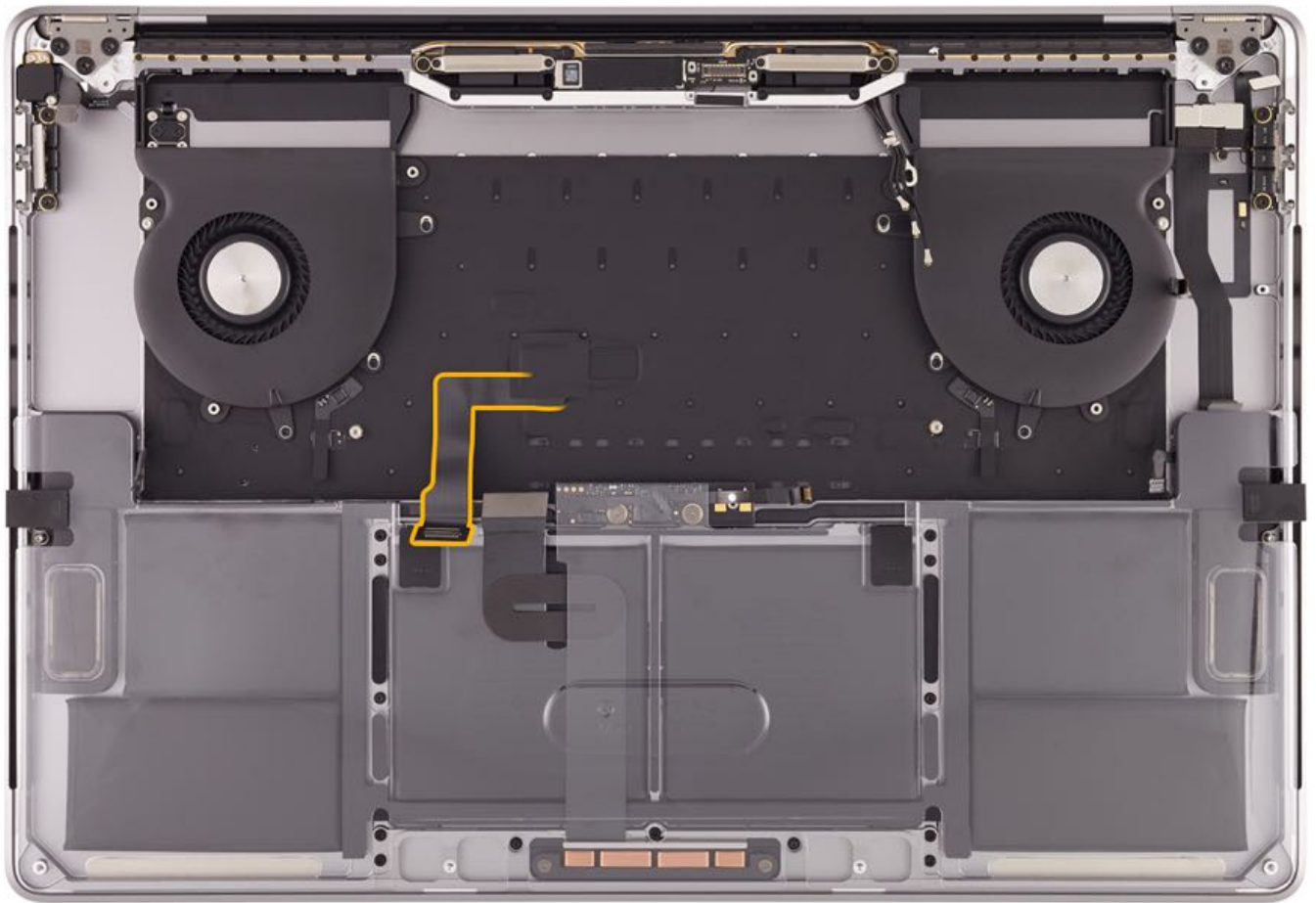
Remove:

- [Bottom case](#)
- [Attach battery cover and disconnect battery](#)
- [Clutch covers](#)
- [Logic board](#)

Keyboard Flex Cable, MacBook Pro (15-inch, 2017):



Keyboard Flex Cable, MacBook Pro (15-inch, 2018 and 2019):



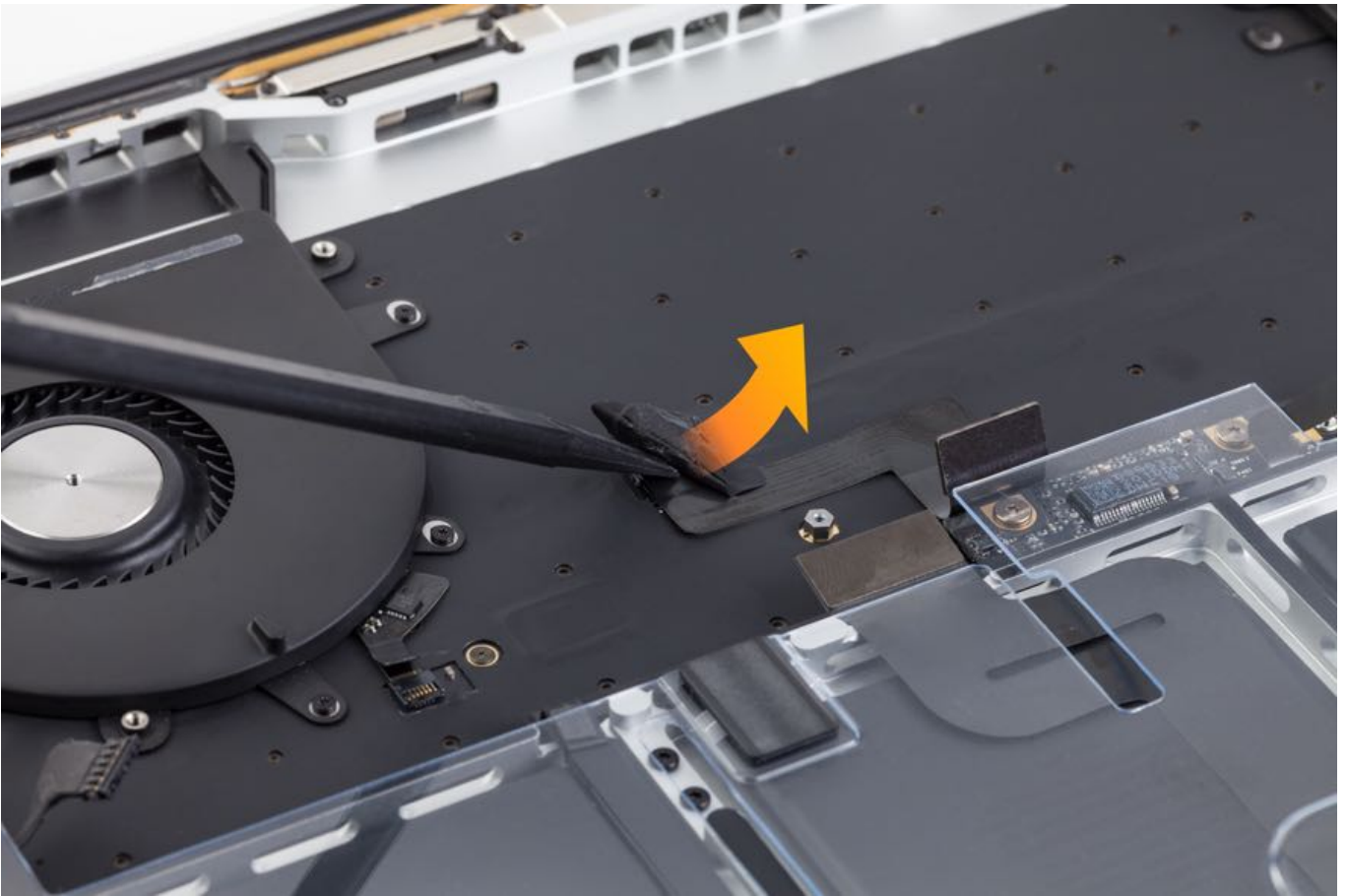
Tools

- Black stick

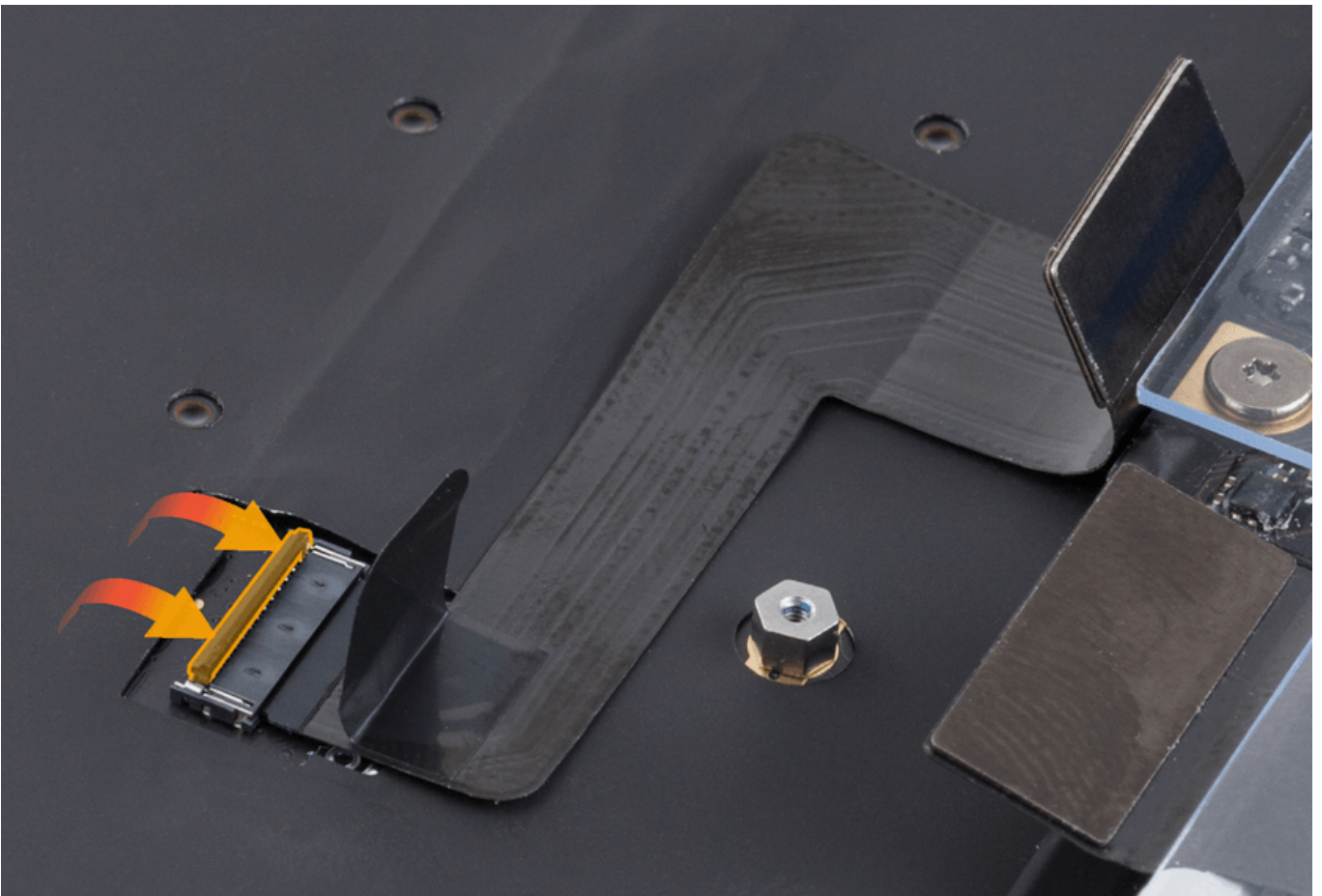


Steps For Removal

1. Use the flat end of a black stick to peel the Mylar cover off the keyboard flex cable.



2. Lift up the locking lever and remove the flex cable.



Steps For Reassembly

1. Reconnect the keyboard flex cable. Secure the locking levers, pressing them flat.
2. Install the new Mylar that is included with the replacement flex cable.

3. Reinstall the [logic board](#).
4. Reinstall the [clutch covers](#).
5. Reinstall the [BMU screw, reconnect the battery, and remove the battery cover](#).
6. Reinstall the [bottom case](#).
7. Follow the instructions in [TP1314: Trackpad Calibration Check](#) to verify the trackpad performance after every repair.

Top Case Assembly with Battery

First Steps



Warning:

- To avoid damaging parts, ensure that you have installed the battery cover, disconnected the battery flex cable, and removed the BMU screw before you begin a repair.
- Do not apply external power while the computer is under repair.

Important:

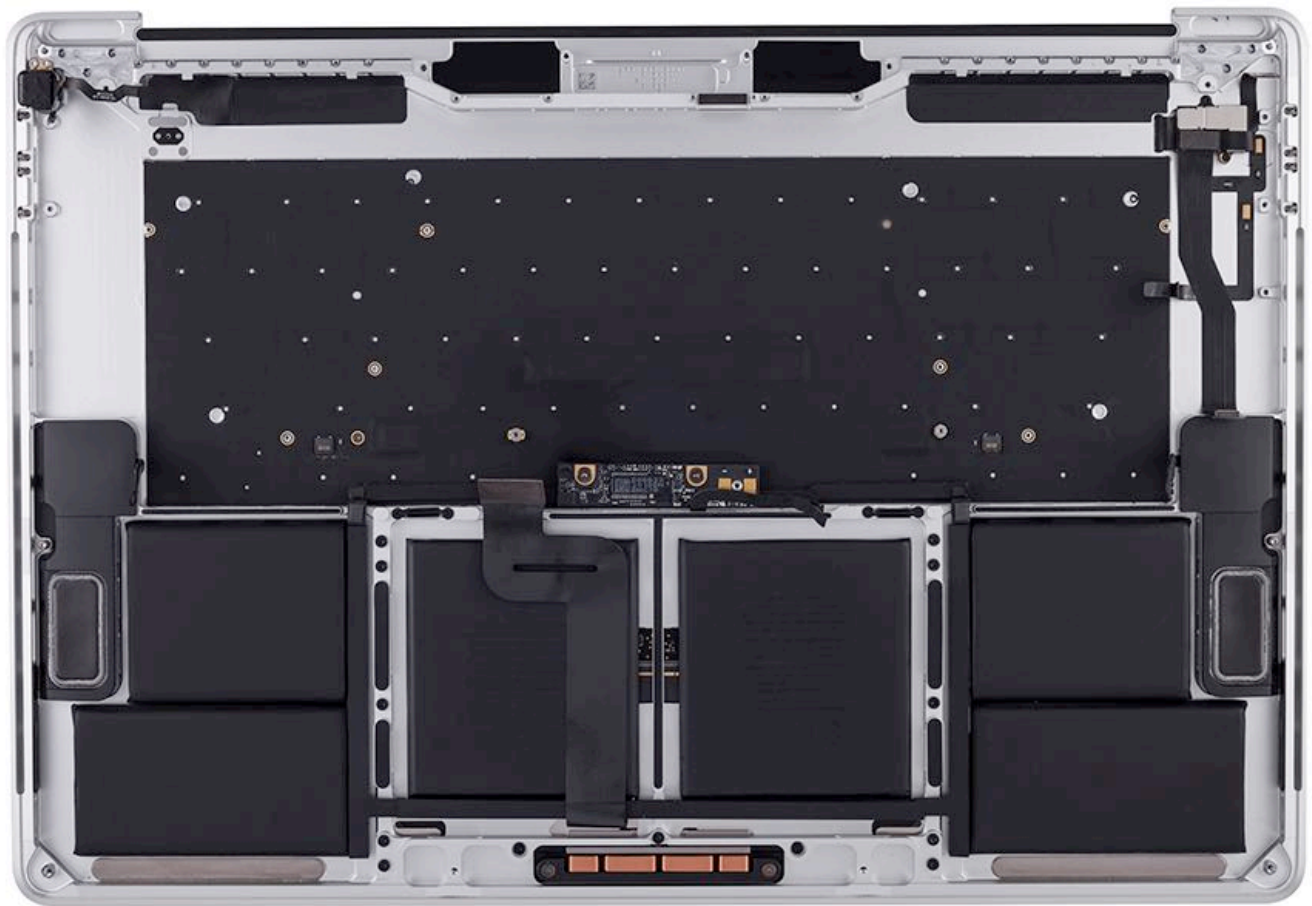
- Only Apple-certified technicians should perform this procedure. For more information, refer to [OP1859: About Apple service certifications](#).
- Wear an ESD wrist strap and take precautions to avoid ESD.
- Regional top cases have the same base part number, but they include a language code prefix (for example, Italian = T661-13163). Confirm the correct keyboard language before replacing the top case. To help determine the correct country code and keyboard language, refer to [HT201794: How to identify keyboard localizations](#).

Caution:

- For MacBook Pro (15-inch, 2018 and 2019) this repair is not complete until System Configuration has been performed. For instructions, refer to [TP1657: System Configuration for Macs with the Apple T2 Security Chip](#).

Remove:

- [Bottom case](#)
- [Attach battery cover and disconnect battery](#)
- [Clutch covers](#)
- [Audio board](#) (2018 and 2019 only)
- [Logic board](#)
- [Vent/antenna module](#)
- [Display assembly](#)
- [Fans](#)
- [I/O boards](#)
- [Touch ID board](#)



Tools

No tools are needed.

Steps For Removal

After all the items listed above are removed, the top case assembly remains.



Warning: The battery is part of the top case module. **Do not attempt to remove the battery from the top case.** For information on packaging a top case assembly with battery for return, see [TP1538: Battery Handling and Storage](#).

These components will also remain in the top case:

- Battery
- Keyboard
- Trackpad
- Microphone
- Trackpad flex cable
- Touch Bar flex cable
- Touch ID board flex cable
 - **Note:** If flex cable is damaged, a replacement is included with the new top case.
- Audio board (2016 and 2017 only)
- Speakers
- Keyboard flex cable

Steps For Reassembly

1. Reassemble in the following order:

- [Display assembly](#)
- [Touch ID](#)
- [I/O boards](#)
- [Fans](#)
- [Vent/antenna module](#)

- [Logic board](#)
- [Audio board](#) (2018 and 2019 only)
- [Clutch covers](#)
- [Remove battery cover and connect the battery](#)
- [BMU flex cable](#) (2018 and 2019 only, replace if bent or damaged)
- [Bottom case](#)



2. Caution:

- For MacBook Pro (2018 and 2019) this repair is not complete until the System Configuration has been performed. For instructions, refer to article [TP1657: System Configuration for Macs with the Apple T2 Security Chip](#).

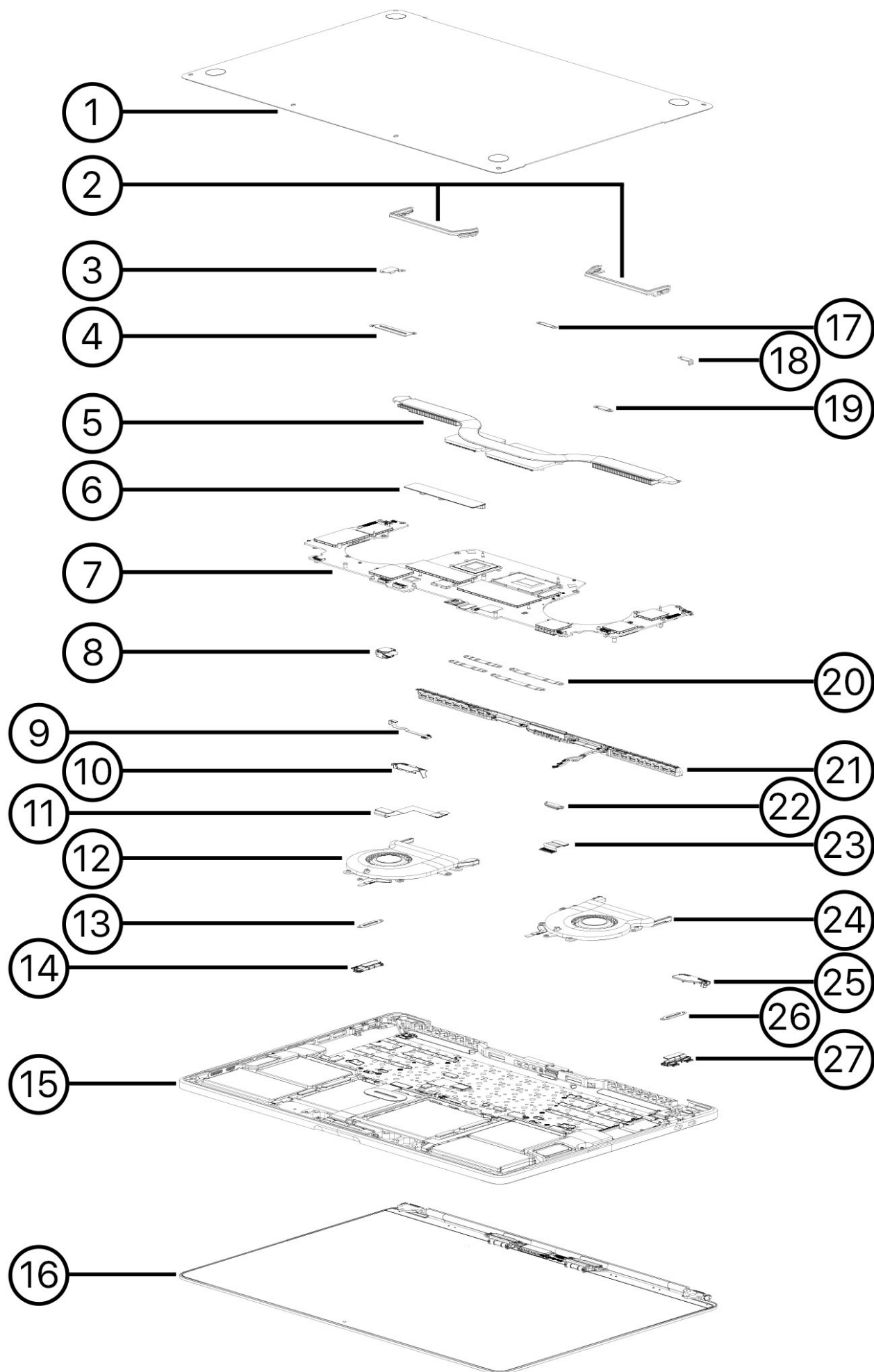
3. For MacBook Pro (2016 and 2017) perform the following AST 2 diagnostic suites in the following order:

- Trackpad Calibration Check
- Touch ID and Touch Bar
- Touch Bar Response

4. Follow the instructions in [TP1314: Trackpad Calibration Check](#) to verify the trackpad performance after every repair.

Exploded View

Exploded View for MacBook Pro (15-inch, 2018)



1. Bottom Case

- For computers with Radeon Pro 555X or Radeon Pro 560X graphics cards:
 - 923-02509, space gray
 - 923-02510, silver
- For computers with Radeon Pro Vega 16 or Radeon Pro Vega 20 graphics cards:
 - 923-00485, space gray
 - 923-00486, silver

2. Thermal Duct (pair)

- 923-01461

3. Cowling, Touch ID Board and Audio Board Flex

- 923-01488

4. Cowling, Trackpad and Keyboard Flex

- 923-02508

5. Heat Sink

- For computers with Radeon Pro 555X or Radeon Pro 560X graphics cards:
 - 076-00383
- For computers with Radeon Pro Vega 16 or Radeon Pro Vega 20 graphics cards:
 - 076-00406

6. BMU Mylar Cover

- 923-02447

7. Logic Board with Radeon Pro 555X or Radeon Pro 560X

- 661-09989, i7, 2.2GHz, 16GB, 256GB, Radeon Pro 555X
- 661-09990, i7, 2.2GHz, 16GB, 512GB, Radeon Pro 555X
- 661-09991, i7, 2.2GHz, 16GB, 1TB, Radeon Pro 555X
- 661-09992, i7, 2.2GHz, 16GB, 2TB, Radeon Pro 555X
- 661-09993, i7, 2.2GHz, 16GB, 4TB, Radeon Pro 555X
- 661-09994, i7, 2.2GHz, 16GB, 256GB, Radeon Pro 560X
- 661-09995, i7, 2.2GHz, 16GB, 512GB, Radeon Pro 560X
- 661-09996, i7, 2.2GHz, 16GB, 1TB, Radeon Pro 560X
- 661-09997, i7, 2.2GHz, 16GB, 2TB, Radeon Pro 560X
- 661-09998, i7, 2.2GHz, 16GB, 4TB, Radeon Pro 560X
- 661-09999, i7, 2.2GHz, 32GB, 256GB, Radeon Pro 555X
- 661-10000, i7, 2.2GHz, 32GB, 512GB, Radeon Pro 555X
- 661-10001, i7, 2.2GHz, 32GB, 1TB, Radeon Pro 555X
- 661-10002, i7, 2.2GHz, 32GB, 2TB, Radeon Pro 555X
- 661-10003, i7, 2.2GHz, 32GB, 4TB, Radeon Pro 555X
- 661-10004, i7, 2.2GHz, 32GB, 256GB, Radeon Pro 560X
- 661-10005, i7, 2.2GHz, 32GB, 512GB, Radeon Pro 560X
- 661-10006, i7, 2.2GHz, 32GB, 1TB, Radeon Pro 560X
- 661-10007, i7, 2.2GHz, 32GB, 2TB, Radeon Pro 560X
- 661-10008, i7, 2.2GHz, 32GB, 4TB, Radeon Pro 560X
- 661-10009, i7, 2.6GHz, 16GB, 512GB, Radeon Pro 560X
- 661-10010, i7, 2.6GHz, 16GB, 1TB, Radeon Pro 560X
- 661-10011, i7, 2.6GHz, 16GB, 2TB, Radeon Pro 560X
- 661-10012, i7, 2.6GHz, 16GB, 4TB, Radeon Pro 560X
- 661-10013, i7, 2.6GHz, 32GB, 512GB, Radeon Pro 560X
- 661-10014, i7, 2.6GHz, 32GB, 1TB, Radeon Pro 560X
- 661-10015, i7, 2.6GHz, 32GB, 2TB, Radeon Pro 560X
- 661-10016, i7, 2.6GHz, 32GB, 4TB, Radeon Pro 560X
- 661-10017, i9, 2.9GHz, 16GB, 256GB, Radeon Pro 555X
- 661-10018, i9, 2.9GHz, 16GB, 512GB, Radeon Pro 555X
- 661-10019, i9, 2.9GHz, 16GB, 1TB, Radeon Pro 555X
- 661-10020, i9, 2.9GHz, 16GB, 2TB, Radeon Pro 555X
- 661-10021, i9, 2.9GHz, 16GB, 4TB, Radeon Pro 555X
- 661-10022, i9, 2.9GHz, 16GB, 256GB, Radeon Pro 560X
- 661-10023, i9, 2.9GHz, 16GB, 512GB, Radeon Pro 560X
- 661-10024, i9, 2.9GHz, 16GB, 1TB, Radeon Pro 560X
- 661-10025, i9, 2.9GHz, 16GB, 2TB, Radeon Pro 560X
- 661-10026, i9, 2.9GHz, 16GB, 4TB, Radeon Pro 560X

- 661-10027, i9, 2.9GHz, 32GB, 256GB, Radeon Pro 555X
- 661-10028, i9, 2.9GHz, 32GB, 512GB, Radeon Pro 555X
- 661-10029, i9, 2.9GHz, 32GB, 1TB, Radeon Pro 555X
- 661-10030, i9, 2.9GHz, 32GB, 2TB, Radeon Pro 555X
- 661-10031, i9, 2.9GHz, 32GB, 4TB, Radeon Pro 555X
- 661-10032, i9, 2.9GHz, 32GB, 256GB, Radeon Pro 560X
- 661-10033, i9, 2.9GHz, 32GB, 512GB, Radeon Pro 560X
- 661-10034, i9, 2.9GHz, 32GB, 1TB, Radeon Pro 560X
- 661-10035, i9, 2.9GHz, 32GB, 2TB, Radeon Pro 560X
- 661-10036, i9, 2.9GHz, 32GB, 4TB, Radeon Pro 560X

Logic Board with Radeon Pro Vega 16 or Radeon Pro Vega 20

- 661-10173, Logic Board, i9, 2.6GHz, 16GB, 512GB, Radeon Pro Vega 16
- 661-10174, Logic Board, i9, 2.6GHz, 16GB, 1TB, Radeon Pro Vega 16
- 661-10175, Logic Board, i9, 2.6GHz, 16GB, 1TB, Radeon Pro Vega 16
- 661-10176, Logic Board, i9, 2.6GHz, 16GB, 1TB, Radeon Pro Vega 16
- 661-10177, Logic Board, i9, 2.6GHz, 16GB, 512GB, Radeon Pro Vega 20
- 661-10178, Logic Board, i9, 2.6GHz, 16GB, 1TB, Radeon Pro Vega 20
- 661-10179, Logic Board, i9, 2.6GHz, 16GB, 2TB, Radeon Pro Vega 20
- 661-10180, Logic Board, i9, 2.6GHz, 16GB, 4TB, Radeon Pro Vega 20
- 661-10181, Logic Board, i9, 2.6GHz, 32GB, 512GB, Radeon Pro Vega 16
- 661-10182, Logic Board, i9, 2.6GHz, 32GB, 1TB, Radeon Pro Vega 16
- 661-10183, Logic Board, i9, 2.6GHz, 32GB, 2TB, Radeon Pro Vega 16
- 661-10184, Logic Board, i9, 2.6GHz, 32GB, 4TB, Radeon Pro Vega 16
- 661-10185, Logic Board, i9, 2.6GHz, 32GB, 512GB, Radeon Pro Vega 20
- 661-10186, Logic Board, i9, 2.6GHz, 32GB, 1TB, Radeon Pro Vega 20
- 661-10187, Logic Board, i9, 2.6GHz, 32GB, 2TB, Radeon Pro Vega 20
- 661-10188, Logic Board, i9, 2.6GHz, 32GB, 4TB, Radeon Pro Vega 20
- 661-10189, Logic Board, i9, 2.9GHz, 16GB, 512GB, Radeon Pro Vega 16
- 661-10190, Logic Board, i9, 2.9GHz, 16GB, 1TB, Radeon Pro Vega 16
- 661-10191, Logic Board, i9, 2.9GHz, 16GB, 2TB, Radeon Pro Vega 16
- 661-10192, Logic Board, i9, 2.9GHz, 16GB, 4TB, Radeon Pro Vega 16
- 661-10193, Logic Board, i9, 2.9GHz, 16GB, 512GB, Radeon Pro Vega 20
- 661-10194, Logic Board, i9, 2.9GHz, 16GB, 1TB, Radeon Pro Vega 20
- 661-10195, Logic Board, i9, 2.9GHz, 16GB, 2TB, Radeon Pro Vega 20
- 661-10196, Logic Board, i9, 2.9GHz, 16GB, 4TB, Radeon Pro Vega 20
- 661-10197, Logic Board, i9, 2.9GHz, 32GB, 512GB, Radeon Pro Vega 16
- 661-10198, Logic Board, i9, 2.9GHz, 32GB, 1TB, Radeon Pro Vega 16
- 661-10199, Logic Board, i9, 2.9GHz, 32GB, 2TB, Radeon Pro Vega 16
- 661-10200, Logic Board, i9, 2.9GHz, 32GB, 4TB, Radeon Pro Vega 16
- 661-10201, Logic Board, i9, 2.9GHz, 32GB, 512GB, Radeon Pro Vega 20
- 661-10202, Logic Board, i9, 2.9GHz, 32GB, 1TB, Radeon Pro Vega 20

8. Audio Board

- 923-02495, space gray
- 923-02496, silver

9. Keyboard Flex Cable

- 923-02494, ANSI/ISO
- 923-02503, JIS

10. Clutch Cover, Right

- 923-02500

11. Touch ID Board

- 661-10344

12. Fan, Right

- 923-02539

13. Cowling, USB-C

- 923-02506

14. I/O Board, Right

- 923-02497

15. Top Case with Battery (includes speakers, trackpad flex cable, microphone, trackpad, keyboard, Touch Bar flex cable, and Touch ID flex cable)

- 661-10345, space gray
- 661-10346, space gray, OOW
- 661-10347, silver
- 661-10348, silver, OOW

Note: Regional top cases have the same base part number, but they include a language code prefix (for example, Italian = T661-10345). Be sure to choose the correct keyboard language when ordering a top case. To help determine the correct country code and keyboard language, refer to [HT201794: How to identify keyboard localizations](#). The language prefixes are:

- | | |
|------------------------------|----------------------------|
| • AB: Arabic | • KH: Korean |
| • B: British (Great Britain) | • MG: Hungarian |
| • BG: Bulgarian | • N: Dutch |
| • C: Canadian French | • PO: Portuguese |
| • CH: Chinese Simplified | • RO: Romanian |
| • CR: Croatian | • RS: Russian |
| • CZ: Czech | • S: Swedish |
| • D: German | • SF: Swiss French |
| • DK: Danish | • SL: Slovak |
| • E: Spanish | • SM: Swiss Multilingual |
| • F: French | • T: Italian |
| • FN: Belgian | • TA: Taiwanese |
| • GR: Greek | • TH: Thai |
| • H: Norwegian Bokmal | • TQ: Turkish (Turkey) |
| • HB: Hebrew | • TU: Turkish (Turkish) |
| • IS: Icelandic | • VN: Vietnam |
| • J: Japanese | • Z: English International |

Top case keyboards may not be available in all localizations.

16. Display Assembly

- 661-10355, space gray
- 661-10356, silver

17. Cowling, eDP (upper)

- 923-01310

18. Cowling, Touch Bar Touch

- 923-01490

19. Cowling, Touch Bar Display

- 923-02507

20. GPU Heat Sink Flexures (left)

- 923-01483

CPU Heat Sink Flexures (right)

- 923-02505

21. Vent/Antenna Module

- 923-02501

22. Cowling, eDP (lower)

- 923-02504

23. eDP Flex Cable

- 923-02502

24. Fan, Left

- 923-02538

25. Clutch Cover, Left

- 923-02499

26. Cowling, USB-C

- 923-02506

27. I/O Board, Left

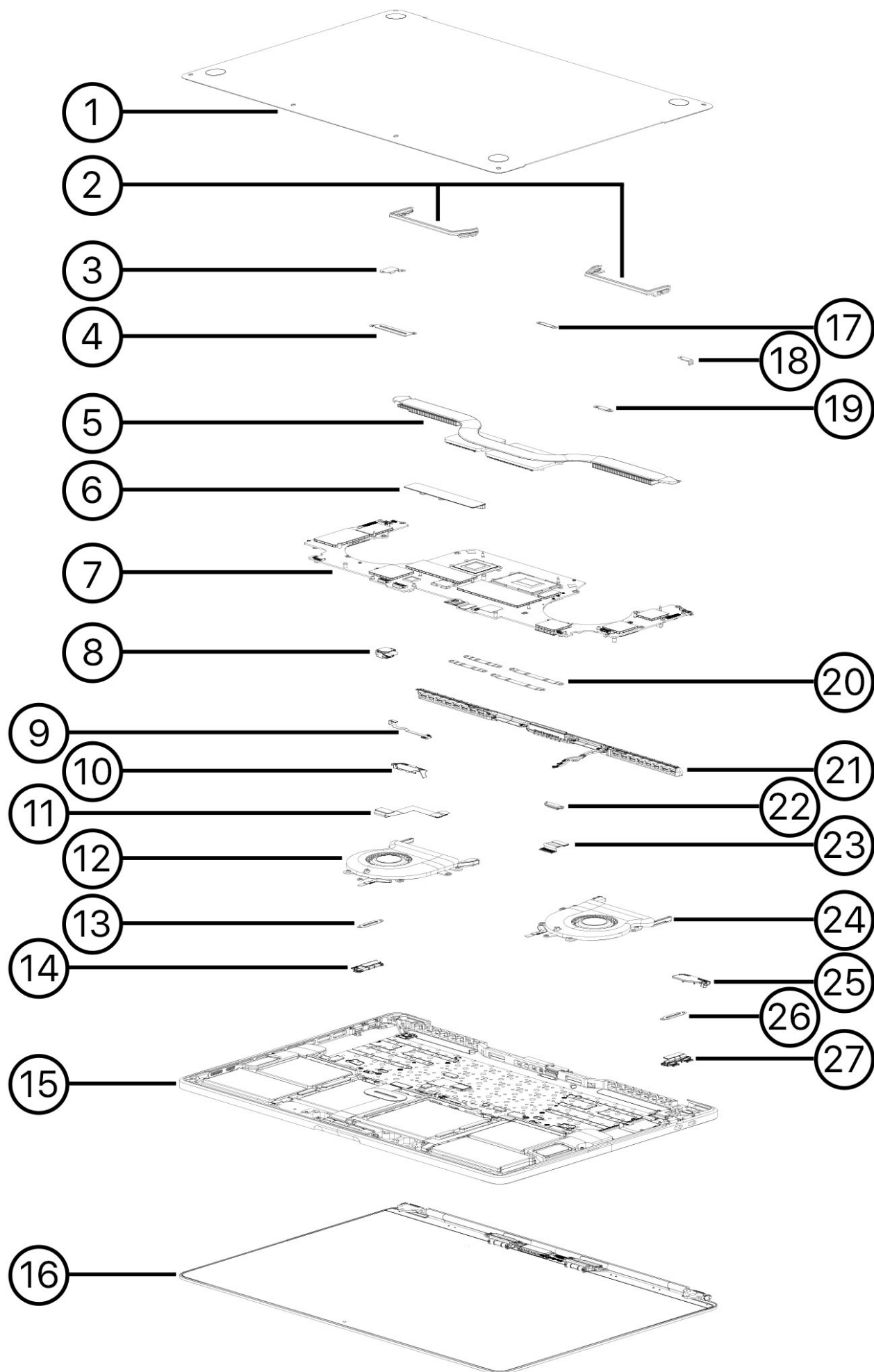
- 923-02497

Not shown:

- Flexure, Touch ID Board, 3-pack, 923-01740
- BMU Flex Cable, 923-02540

Exploded View

Exploded View for MacBook Pro (15-inch, 2019)



1. Bottom Case

- 923-03191, space gray
- 923-03192, silver

2. Thermal Duct (pair)

- 923-01461

3. Cowling, Touch ID Board and Audio Board Flex

- 923-01488

4. Cowling, Trackpad and Keyboard Flex

- 923-02508

5. Heat Sink

- For computers with Radeon Pro 555X or Radeon Pro 560X graphics cards:
 - 076-00383
- For computers with Radeon Pro Vega 16 or Radeon Pro Vega 20 graphics cards:
 - 076-00406

6. BMU Mylar Cover

- 923-02447

7. Logic Board

- 661-12862, Logic Board, i7, 2.3GHz, 16GB, 1TB, Radeon Pro 560X
- 661-12863, Logic Board, i7, 2.3GHz, 16GB, 2TB, Radeon Pro 560X
- 661-12864, Logic Board, i7, 2.3GHz, 16GB, 4TB, Radeon Pro 560X
- 661-12865, Logic Board, i7, 2.3GHz, 16GB, 512GB, Radeon Pro 560X
- 661-12866, Logic Board, i7, 2.3GHz, 32GB, 1TB, Radeon Pro 560X
- 661-12867, Logic Board, i7, 2.3GHz, 32GB, 2TB, Radeon Pro 560X
- 661-12868, Logic Board, i7, 2.3GHz, 32GB, 4TB, Radeon Pro 560X
- 661-12869, Logic Board, i7, 2.3GHz, 32GB, 512GB, Radeon Pro 560X
- 661-12870, Logic Board, i7, 2.6GHz, 16GB, 1TB, Radeon Pro 555X
- 661-12871, Logic Board, i7, 2.6GHz, 16GB, 256GB, Radeon Pro 555X
- 661-12872, Logic Board, i7, 2.6GHz, 16GB, 2TB, Radeon Pro 555X
- 661-12873, Logic Board, i7, 2.6GHz, 16GB, 4TB, Radeon Pro 555X
- 661-12874, Logic Board, i7, 2.6GHz, 16GB, 512GB, Radeon Pro 555X
- 661-12875, Logic Board, i7, 2.6GHz, 32GB, 1TB, Radeon Pro 555X
- 661-12876, Logic Board, i7, 2.6GHz, 32GB, 256GB, Radeon Pro 555X
- 661-12877, Logic Board, i7, 2.6GHz, 32GB, 2TB, Radeon Pro 555X
- 661-12878, Logic Board, i7, 2.6GHz, 32GB, 4TB, Radeon Pro 555X
- 661-12879, Logic Board, i7, 2.6GHz, 32GB, 512GB, Radeon Pro 555X
- 661-12880, Logic Board, i7, 2.6GHz, 16GB, 1TB, Radeon Pro 560X
- 661-12881, Logic Board, i7, 2.6GHz, 16GB, 256GB, Radeon Pro 560X
- 661-12882, Logic Board, i7, 2.6GHz, 16GB, 2TB, Radeon Pro 560X
- 661-12883, Logic Board, i7, 2.6GHz, 16GB, 4TB, Radeon Pro 560X
- 661-12884, Logic Board, i7, 2.6GHz, 16GB, 512GB, Radeon Pro 560X
- 661-12885, Logic Board, i7, 2.6GHz, 32GB, 1TB, Radeon Pro 560X
- 661-12886, Logic Board, i7, 2.6GHz, 32GB, 256GB, Radeon Pro 560X
- 661-12887, Logic Board, i7, 2.6GHz, 32GB, 2TB, Radeon Pro 560X
- 661-12888, Logic Board, i7, 2.6GHz, 32GB, 4TB, Radeon Pro 560X
- 661-12889, Logic Board, i9, 2.6GHz, 32GB, 512GB, Radeon Pro 560X
- 661-12890, Logic Board, i9, 2.3GHz, 16GB, 1TB, Radeon Pro Vega 16
- 661-12891, Logic Board, i9, 2.3GHz, 16GB, 2TB, Radeon Pro Vega 16
- 661-12892, Logic Board, i9, 2.3GHz, 16GB, 4TB, Radeon Pro Vega 16
- 661-12893, Logic Board, i9, 2.3GHz, 16GB, 512GB, Radeon Pro Vega 16
- 661-12894, Logic Board, i9, 2.3GHz, 32GB, 1TB, Radeon Pro Vega 16
- 661-12895, Logic Board, i9, 2.3GHz, 32GB, 2TB, Radeon Pro Vega 16
- 661-12896, Logic Board, i9, 2.3GHz, 32GB, 4TB, Radeon Pro Vega 16
- 661-12897, Logic Board, i9, 2.3GHz, 32GB, 512GB, Radeon Pro Vega 16
- 661-12898, Logic Board, i9, 2.3GHz, 16GB, 1TB, Radeon Pro Vega 20
- 661-12899, Logic Board, i9, 2.3GHz, 16GB, 2TB, Radeon Pro Vega 20
- 661-12900, Logic Board, i9, 2.3GHz, 16GB, 4TB, Radeon Pro Vega 20
- 661-12901, Logic Board, i9, 2.3GHz, 16GB, 512GB, Radeon Pro Vega 20
- 661-12902, Logic Board, i9, 2.3GHz, 32GB, 1TB, Radeon Pro Vega 20
- 661-12903, Logic Board, i9, 2.3GHz, 32GB, 2TB, Radeon Pro Vega 20

- 661-12904, Logic Board, i9, 2.3GHz, 32GB, 4TB, Radeon Pro Vega 20
- 661-12905, Logic Board, i9, 2.3GHz, 32GB, 512GB, Radeon Pro Vega 20
- 661-12906, Logic Board, i9, 2.4GHz, 16GB, 1TB, Radeon Pro 555X
- 661-12907, Logic Board, i9, 2.4GHz, 16GB, 256GB, Radeon Pro 555X
- 661-12908, Logic Board, i9, 2.4GHz, 16GB, 2TB, Radeon Pro 555X
- 661-12909, Logic Board, i9, 2.4GHz, 16GB, 4TB, Radeon Pro 555X
- 661-12910, Logic Board, i9, 2.4GHz, 16GB, 512GB, Radeon Pro 555X
- 661-12911, Logic Board, i9, 2.4GHz, 32GB, 1TB, Radeon Pro 555X
- 661-12912, Logic Board, i9, 2.4GHz, 32GB, 256GB, Radeon Pro 555X
- 661-12913, Logic Board, i9, 2.4GHz, 32GB, 2TB, Radeon Pro 555X
- 661-12914, Logic Board, i9, 2.4GHz, 32GB, 4TB, Radeon Pro 555X
- 661-12915, Logic Board, i9, 2.4GHz, 32GB, 512GB, Radeon Pro 555X
- 661-12916, Logic Board, i9, 2.4GHz, 16GB, 1TB, Radeon Pro 560X
- 661-12917, Logic Board, i9, 2.4GHz, 16GB, 256GB, Radeon Pro 560X
- 661-12918, Logic Board, i9, 2.4GHz, 16GB, 2TB, Radeon Pro 560X
- 661-12919, Logic Board, i9, 2.4GHz, 16GB, 4TB, Radeon Pro 560X
- 661-12920, Logic Board, i9, 2.4GHz, 16GB, 512GB, Radeon Pro 560X
- 661-12921, Logic Board, i9, 2.4GHz, 32GB, 1TB, Radeon Pro 560X
- 661-12922, Logic Board, i9, 2.4GHz, 32GB, 256GB, Radeon Pro 560X
- 661-12923, Logic Board, i9, 2.4GHz, 32GB, 2TB, Radeon Pro 560X
- 661-12924, Logic Board, i9, 2.4GHz, 32GB, 4TB, Radeon Pro 560X
- 661-12925, Logic Board, i9, 2.4GHz, 32GB, 512GB, Radeon Pro 560X
- 661-12926, Logic Board, i9, 2.4GHz, 16GB, 1TB, Radeon Pro Vega 16
- 661-12927, Logic Board, i9, 2.4GHz, 16GB, 2TB, Radeon Pro Vega 16
- 661-12928, Logic Board, i9, 2.4GHz, 16GB, 4TB, Radeon Pro Vega 16
- 661-12929, Logic Board, i9, 2.4GHz, 16GB, 512GB, Radeon Pro Vega 16
- 661-12930, Logic Board, i9, 2.4GHz, 32GB, 1TB, Radeon Pro Vega 16
- 661-12931, Logic Board, i9, 2.4GHz, 32GB, 2TB, Radeon Pro Vega 16
- 661-12932, Logic Board, i9, 2.4GHz, 32GB, 4TB, Radeon Pro Vega 16
- 661-12933, Logic Board, i9, 2.4GHz, 32GB, 512GB, Radeon Pro Vega 16
- 661-12934, Logic Board, i9, 2.4GHz, 16GB, 1TB, Radeon Pro Vega 20
- 661-12935, Logic Board, i9, 2.4GHz, 16GB, 2TB, Radeon Pro Vega 20
- 661-12936, Logic Board, i9, 2.4GHz, 16GB, 4TB, Radeon Pro Vega 20
- 661-12937, Logic Board, i9, 2.4GHz, 16GB, 512GB, Radeon Pro Vega 20
- 661-12938, Logic Board, i9, 2.4GHz, 32GB, 1TB, Radeon Pro Vega 20
- 661-12930, Logic Board, i9, 2.4GHz, 32GB, 2TB, Radeon Pro Vega 20
- 661-12940, Logic Board, i9, 2.4GHz, 32GB, 4TB, Radeon Pro Vega 20
- 661-12941, Logic Board, i9, 2.4GHz, 32GB, 512GB, Radeon Pro Vega 20

8. Audio Board

- 923-02495, space gray
- 923-02496, silver

9. Keyboard Flex Cable

- 923-02494, ANSI/ISO
- 923-02503, JIS

10. Clutch Cover, Right

- 923-02500

11. Touch ID Board

- 661-10344

12. Fan, Right

- 923-02539

13. Cowling, USB-C

- 923-02506

14. I/O Board, Right

- 923-02497

15. Top Case with Battery (includes speakers, trackpad flex cable, microphone, trackpad, keyboard, Touch Bar flex cable, and Touch ID flex cable)

- 661-13163, space gray
- 661-13164, silver

Note: Regional top cases have the same base part number, but they include a language code prefix (for example, Italian = T661-13163). Be sure to choose the correct keyboard language when ordering a top case. To help determine the correct country code and keyboard language, refer to [HT201794: How to identify keyboard localizations](#). The language prefixes are:

- | | |
|------------------------------|----------------------------|
| • AB: Arabic | • KH: Korean |
| • B: British (Great Britain) | • MG: Hungarian |
| • BG: Bulgarian | • N: Dutch |
| • C: Canadian French | • PO: Portuguese |
| • CH: Chinese Simplified | • RO: Romanian |
| • CR: Croatian | • RS: Russian |
| • CZ: Czech | • S: Swedish |
| • D: German | • SF: Swiss French |
| • DK: Danish | • SL: Slovak |
| • E: Spanish | • SM: Swiss Multilingual |
| • F: French | • T: Italian |
| • FN: Belgian | • TA: Taiwanese |
| • GR: Greek | • TH: Thai |
| • H: Norwegian Bokmal | • TQ: Turkish (Turkey) |
| • HB: Hebrew | • TU: Turkish (Turkish) |
| • IS: Icelandic | • VN: Vietnam |
| • J: Japanese | • Z: English International |

Top case keyboards may not be available in all localizations.

16. Display Assembly

- 661-10355, space gray
- 661-10356, silver

17. Cowling, eDP (upper)

- 923-01310

18. Cowling, Touch Bar Touch

- 923-01490

19. Cowling, Touch Bar Display

- 923-02507

20. GPU Heat Sink Flexures (left)

- 923-01483

CPU Heat Sink Flexures (right)

- 923-02505

21. Vent/Antenna Module

- 923-02501

22. Cowling, eDP (lower)

- 923-02504

23. eDP Flex Cable

- 923-02502

24. Fan, Left

- 923-02538

25. Clutch Cover, Left

- 923-02499

26. Cowling, USB-C

- 923-02506

27. I/O Board, Left















- 923-02497
















Not shown:

- Flexure, Touch ID Board, 3-pack, 923-01740
- BMU Flex Cable, 923-02540
- Batttery Cover, 2-pack, 923-02532

Screw Chart

Screw Chart for MacBook Pro (15-inch, 2016, 2017, 2018, 2019)

<p>923-01516, Silver Pentalobe</p>  <p>Bottom Case, Lower (2)</p>	<p>923-01517, Silver Pentalobe</p>  <p>Bottom Case, Upper Corners, (2)</p>	<p>923-01513, Space Gray Pentalobe</p>  <p>Bottom Case, Lower (2)</p>
<p>923-01514, Space Gray Pentalobe</p>  <p>Bottom Case, Upper Corners, (2)</p>	<p>923-01418 Torx T5</p>  <p>BMU Screw (1)</p>	<p>923-01185 Torx T3</p>  <p>Spring Tensioners (4)</p>
<p>923-01286 Torx T3</p>  <p>Display Clutch Covers (4)</p>	<p>923-01173 Torx T8</p>  <p>Display Assembly Hinge (6)</p>	<p>923-01512 1IPR</p>  <p>Vent/Antenna Module (16)</p>
<p>923-01497 Torx T3</p>  <p>Logic Board (2)</p>	<p>923-01423 Torx T3</p>  <p>Fans (Left and Right) (6)</p>	<p>923-01498 Torx T5</p>  <p>Logic Board (1)</p>
<p>923-01190 Torx T3</p>  <p>eDP Flex Cable to Logic Board (2)</p>	<p>923-01285 Torx T3</p>  <p>eDP Flex Cable Upper Cowling (2) TCON Cowling (4)</p>	<p>923-01510 Torx T3</p>  <p>eDP Flex Cable Lower Cowling (2)</p>

<p>923-01277 Torx T5</p>  <p>TCON Board Screws (4)</p>	<p>923-01502 Torx T8</p>  <p>Heat Sink, Left</p>	<p>923-01505 Torx T8</p>  <p>Heat Sink, Right</p>
<p>923-01507 Torx T5</p>  <p>Heat Sink Flexures GPU (4)</p>	<p>923-01508 Torx T5</p>  <p>Heat Sink Flexures CPU (4)</p>	<p>923-01506 Torx T3</p>  <p>Touch ID and Audio Board Flex Cowling (2)</p>
<p>923-01442 Torx T3</p>  <p>Touch ID (2)</p>	<p>923-01443 Torx T3</p>  <p>Touch ID (4)</p>	<p>923-01501 Torx T3</p>  <p>Trackpad Flex Cowling Keyboard Flex Cowling Touch Bar Display Flex Cowling</p>
<p>923-01411 Torx 3</p>  <p>Touch Bar Touch Flex Cowling I/O Board Cowling Customer Data Migration Connector</p>	<p>923-01515 Torx T3</p>  <p>Fans (Left and Right) (2)</p>	<p>923-01509 Torx T5</p>  <p>I/O Board (Left and Right) (4)</p>
<p>923-01464 Hex driver</p>  <p>Logic Board Standoff</p>	<p>923-02513 Torx 3</p>  <p>I/O Board Cowling (4) (2018 and 2019 only)</p>	<p>923-02530 Torx T3</p>  <p>Audio Board Screw (3) washer included (2018 and 2019 only)</p>

Screw Location Diagrams

Screw Location Diagrams for MacBook Pro (15-inch, 2016, 2017, 2018, 2019)

Bottom Case

- Pentalobe: (position 1)
 - 923-01517 Silver
 - 923-01514 Space Gray

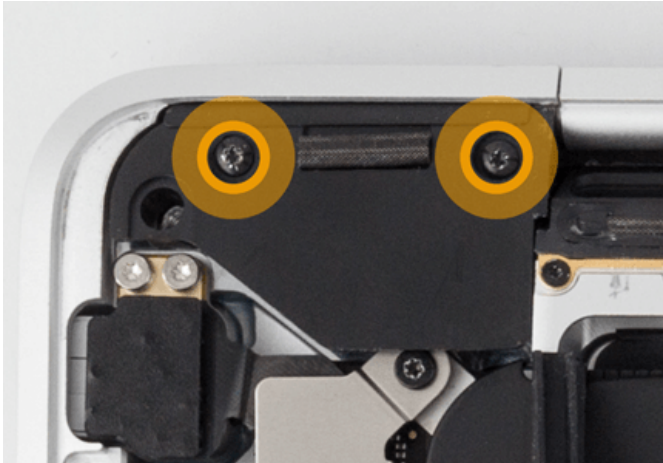


- Pentalobe: (position 2)
 - 923-01516 Silver
 - 923-01513 Space Gray



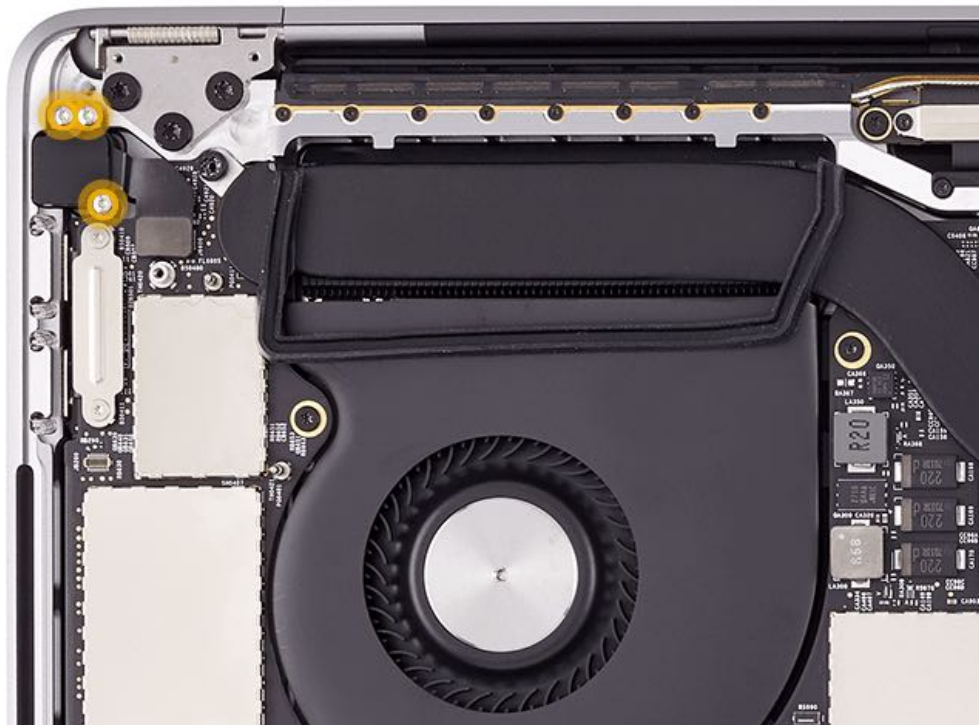
Clutch Covers

- T3: 923-01286



Audio Board (2018)

- T3: 923-02530



Right and Left Fans

- T3: 923-01423 (position 1)



- T3: 923-01515 (position 2)



Logic Board Cowling Screws

1. Touch Bar Touch
2. Left I/O Board
6. Customer Data Migration Tool Connector
7. Right I/O Board

- T3: 923-01411



3. Touch Bar Display
4. Keyboard Flex
5. Trackpad Flex

- T3: 923-01501



8. Touch ID and Audio Board

- T3: 923-01506



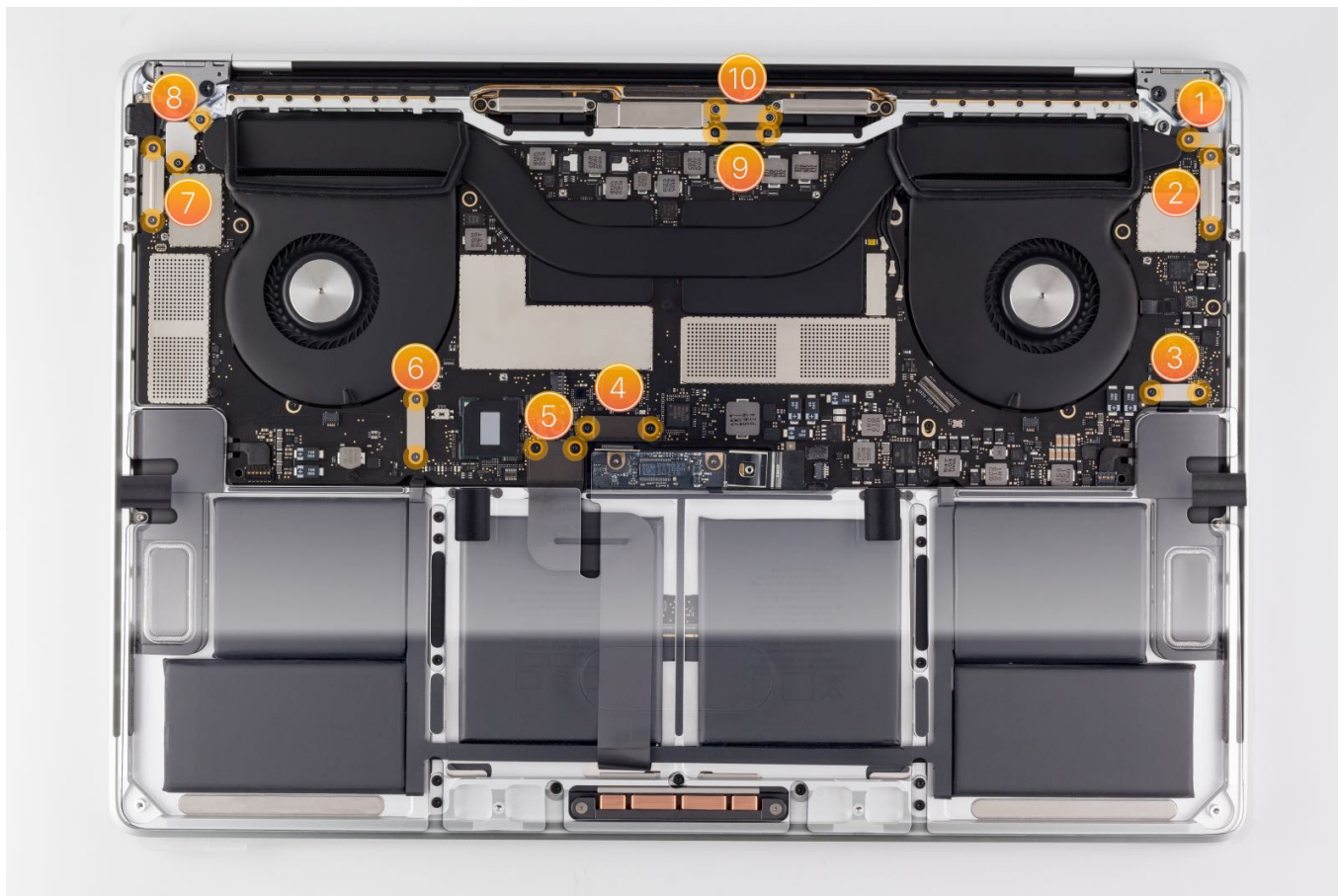
9. Lower eDP flex cable cowl

- T3: 923-01510



10. Upper eDP flex cable cowl

- T3: 923-01285



Logic Board Screws

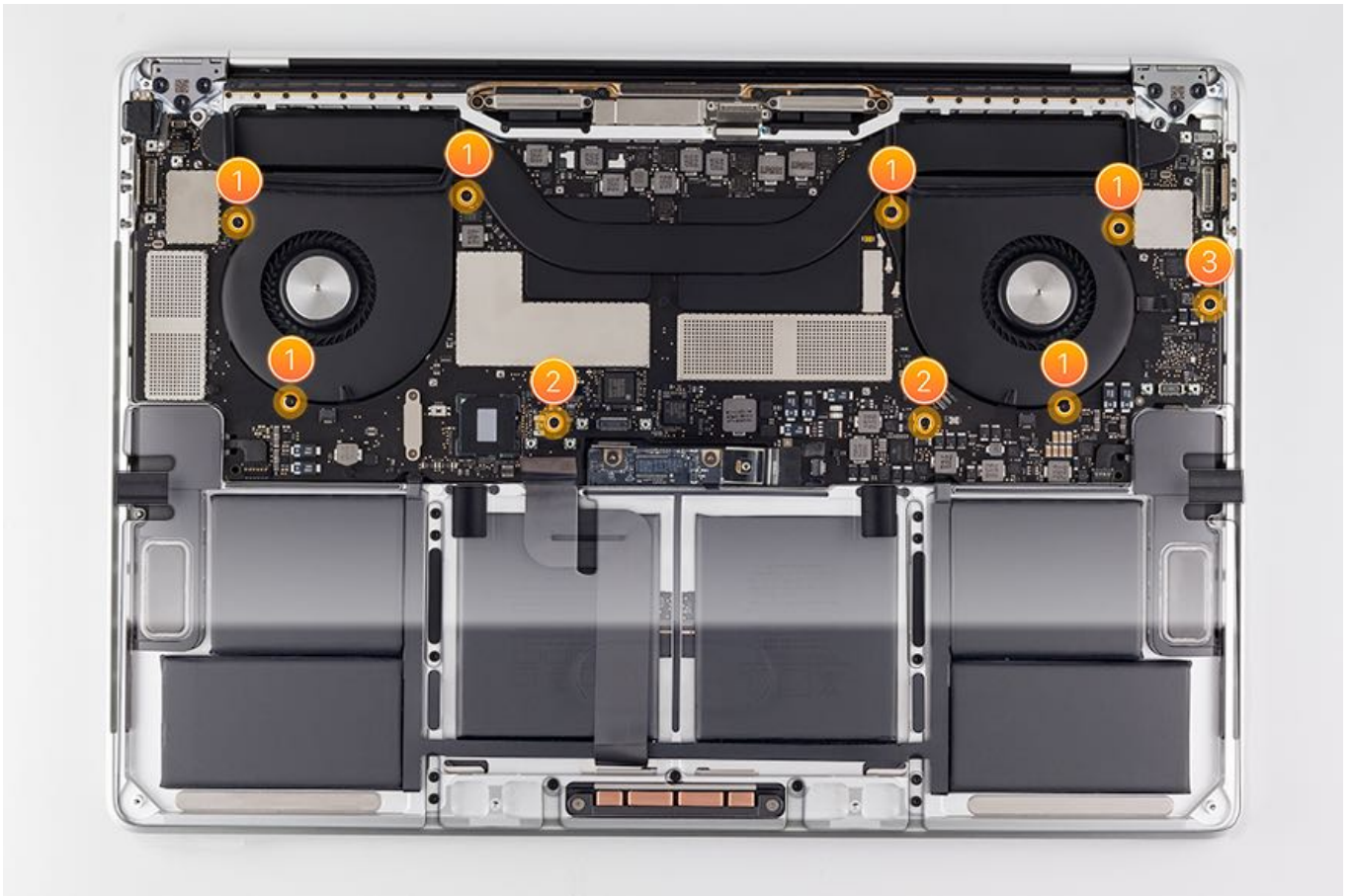
- T5: (position 1)
 - 923-01500



- T3: (position 2)
 - 923-01497

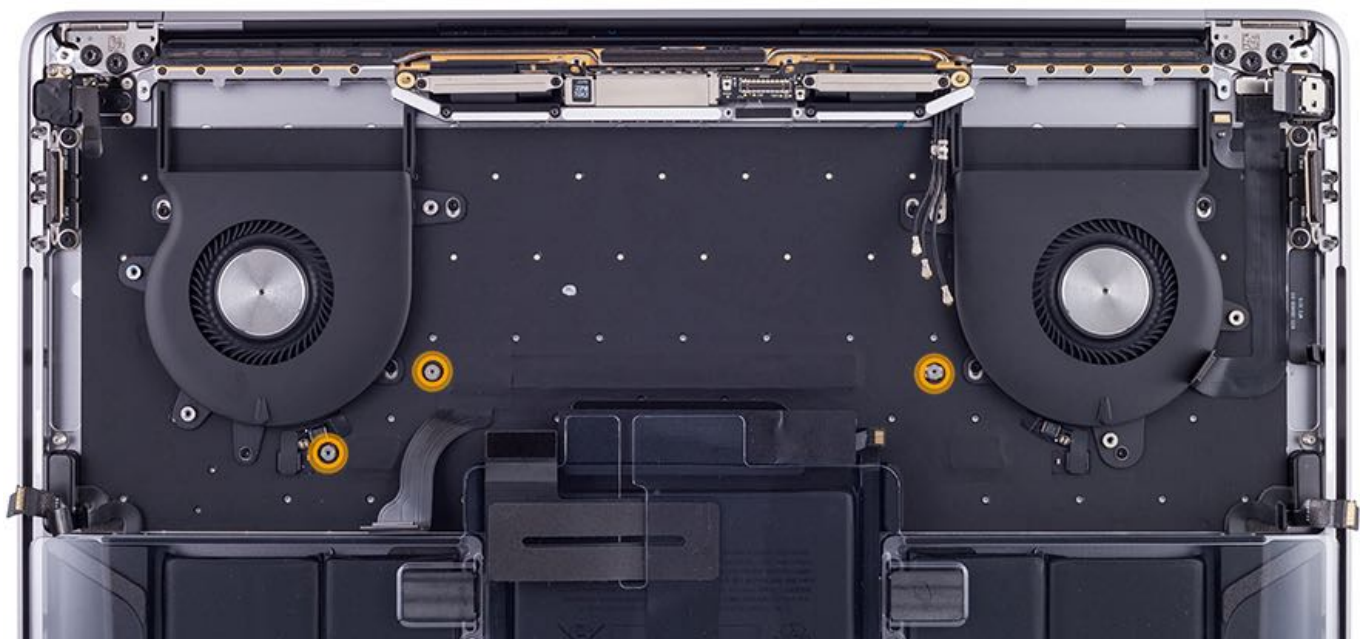


- T5: (position 3)
 - 923-01498

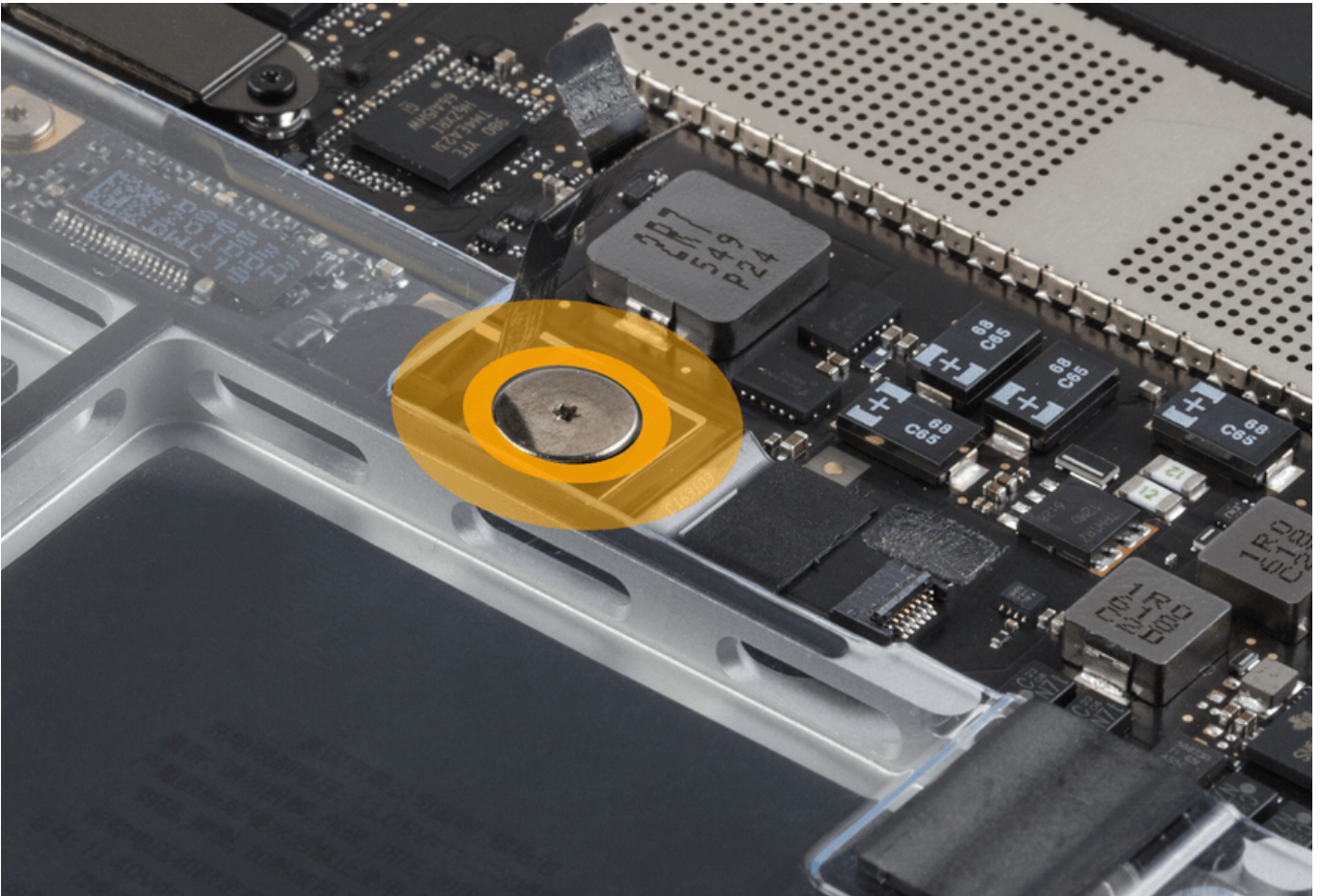


Logic Board Standoffs

- Hex Driver: 923-01464



- T5: 923-01418

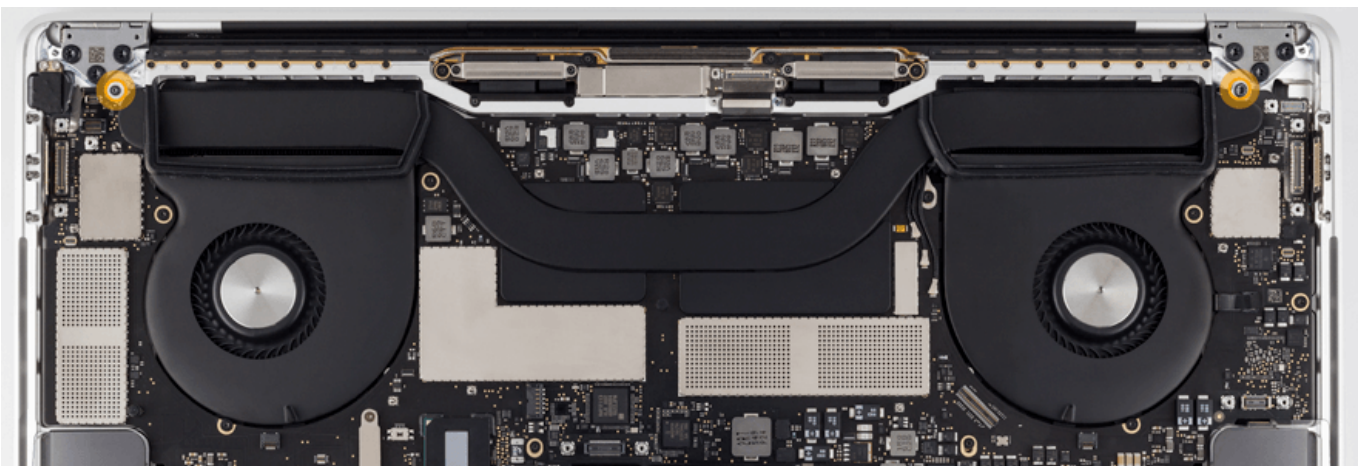


Heat Sink

- T8: 923-01502 (left)

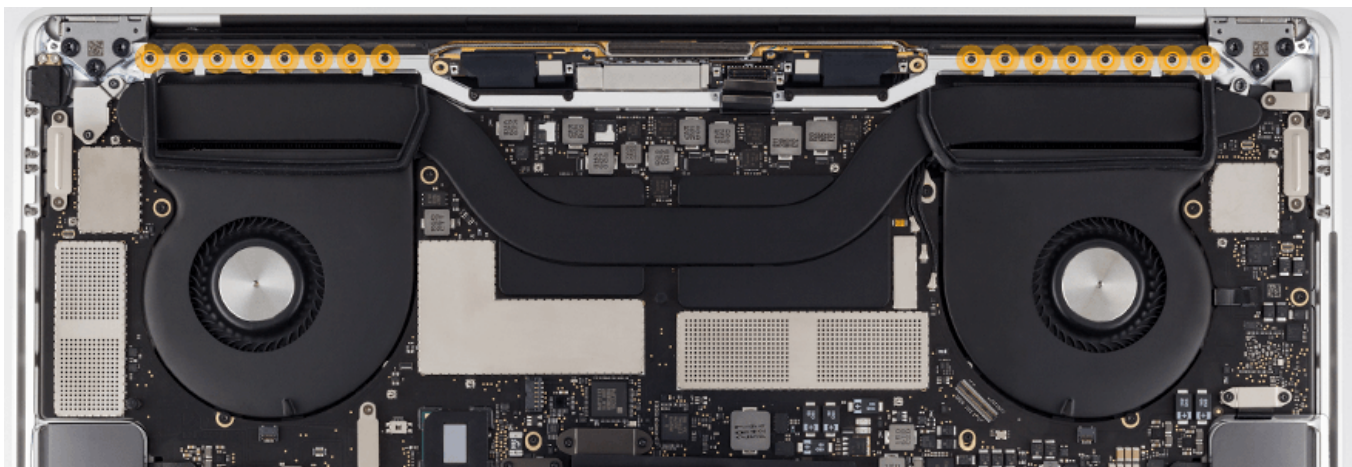


- T8: 923-01505 (right) **Note:** The right screw is a screw within a screw.



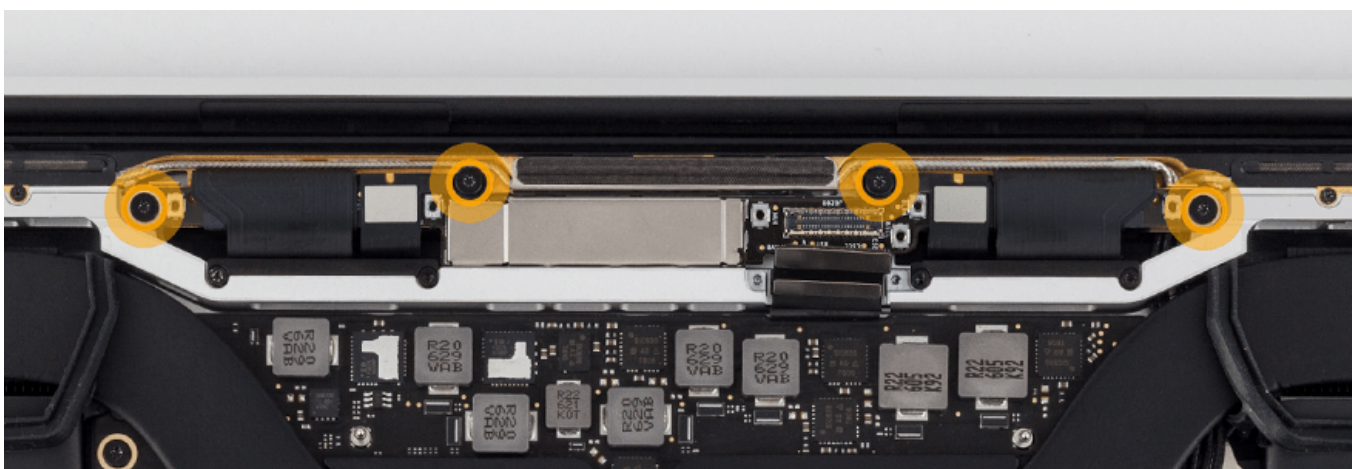
Vent/Antenna Module

- 1IPR: 923-01512



TCON Board

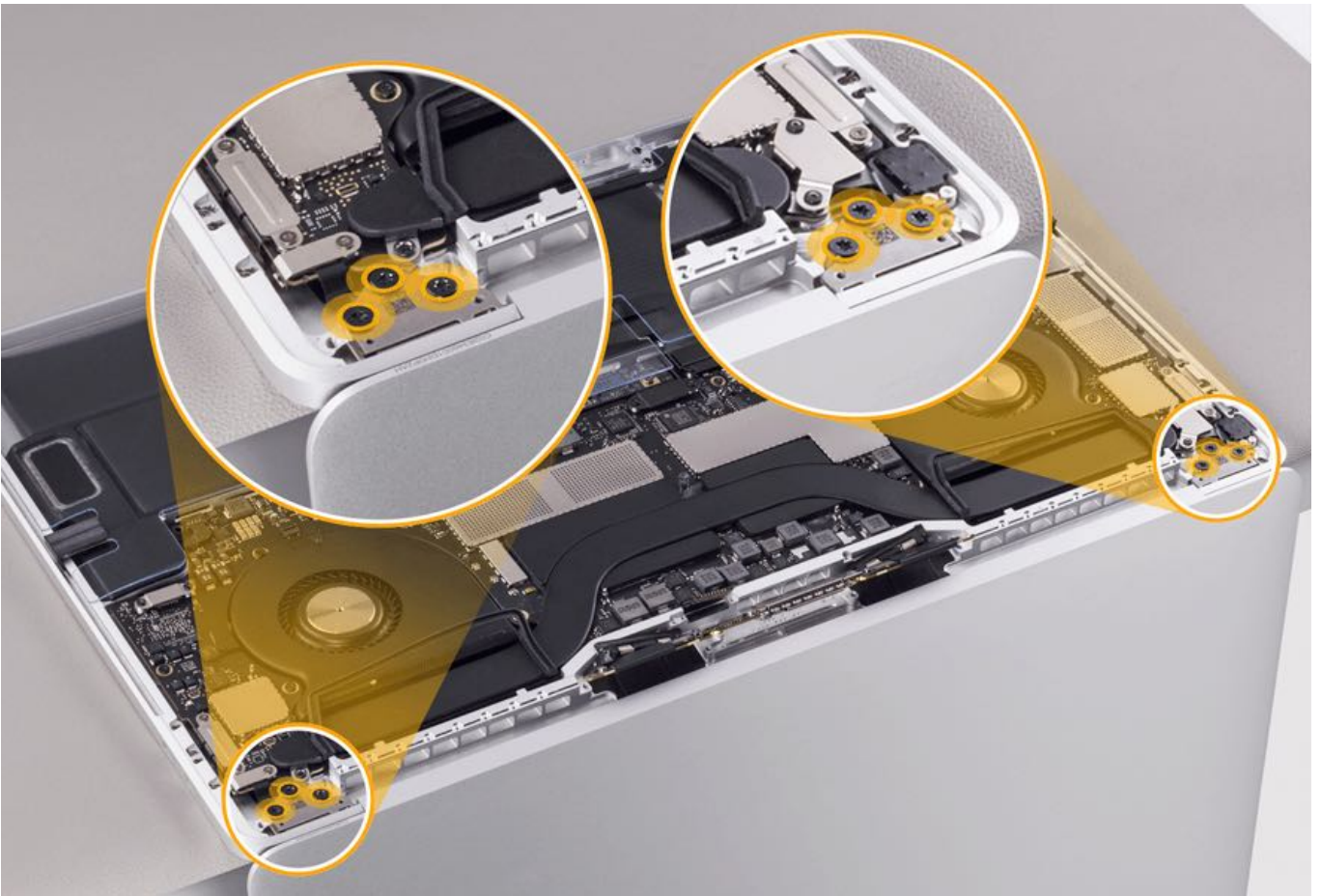
- T5: 923-01277



Display Hinge Screws

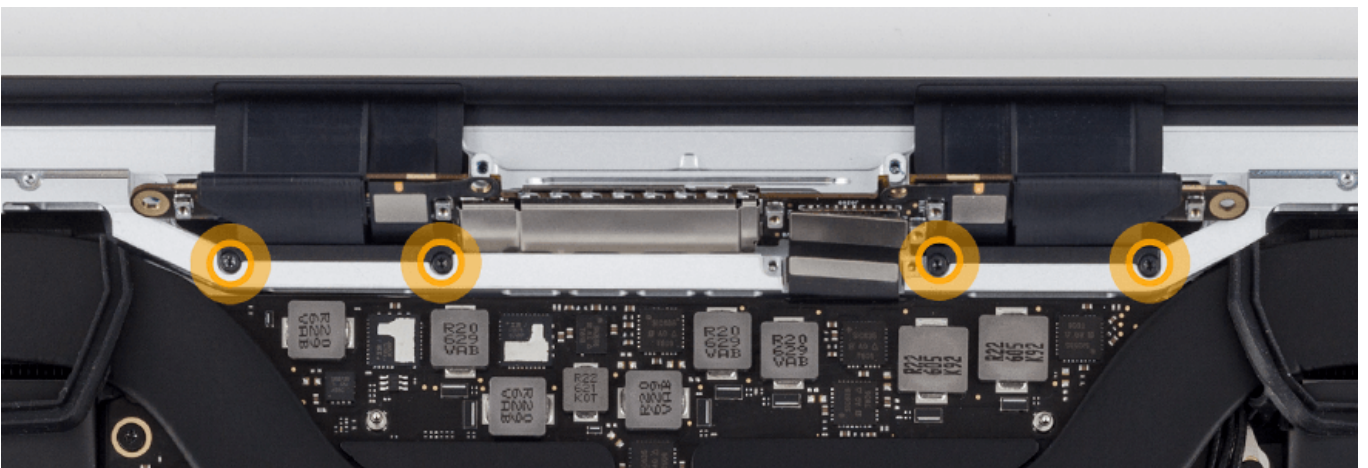
- T8: 923-01173





Spring Tensioners

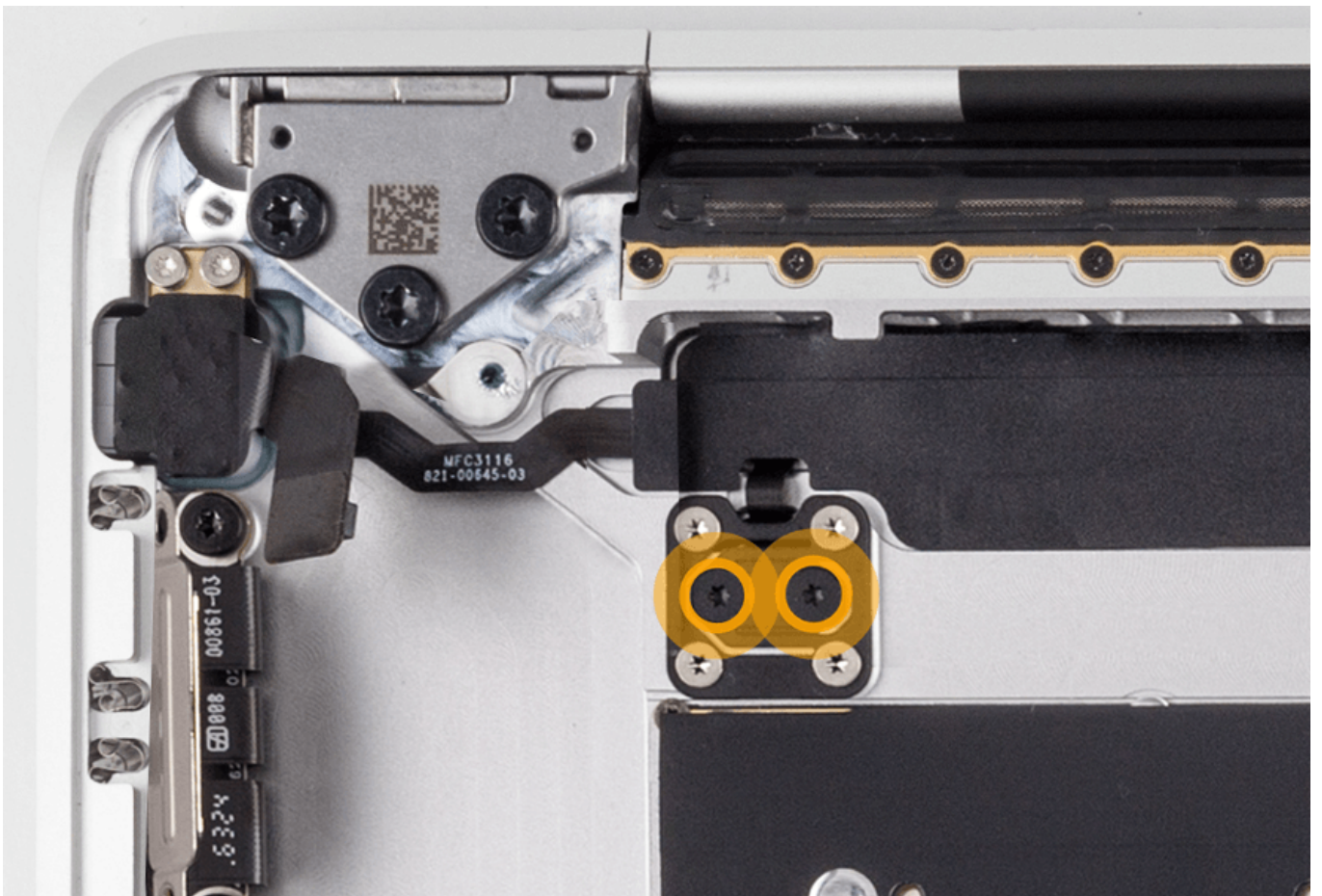
- T3: 923-01185



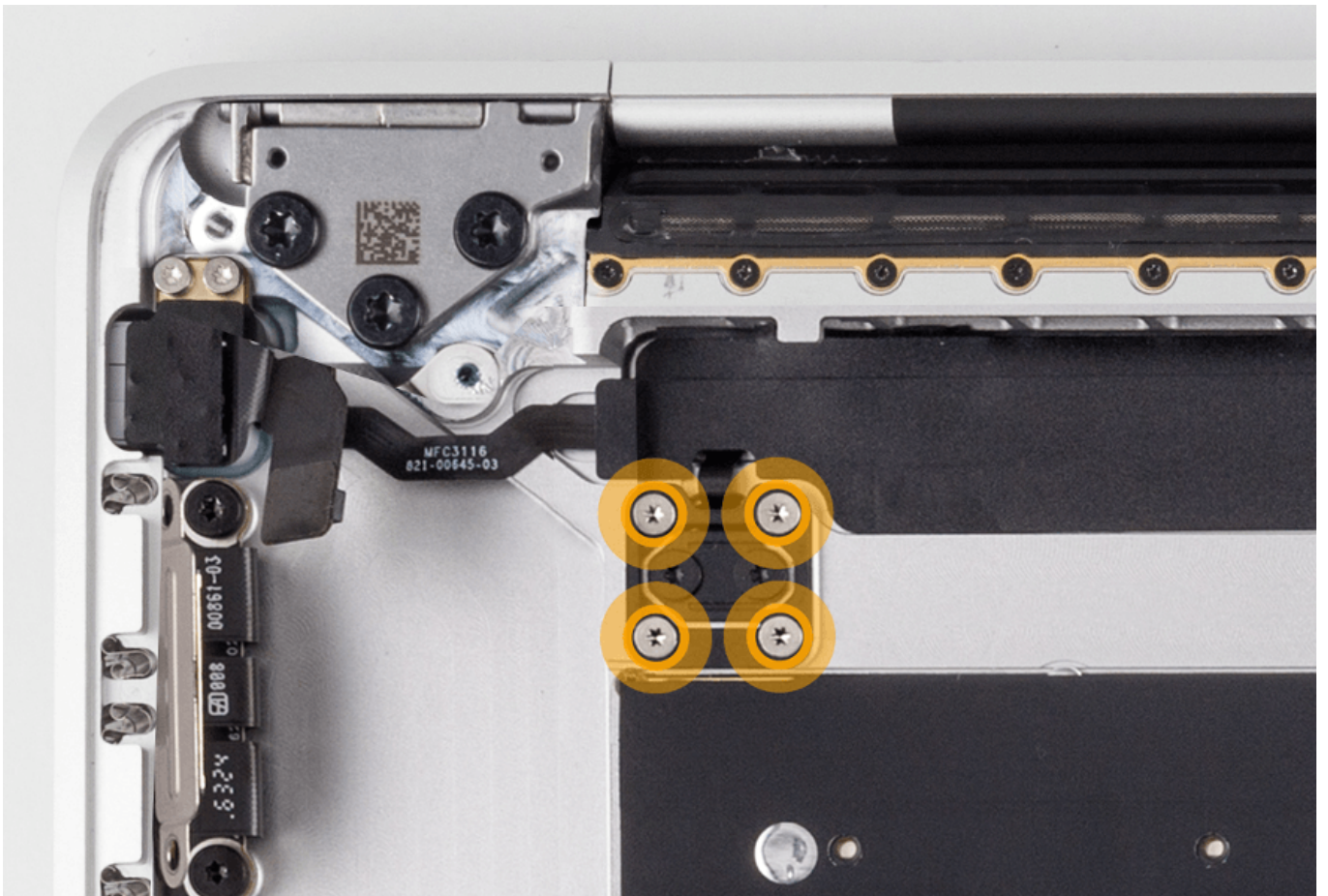
Touch ID Board

- T3: 923-01442





- T3: 923-01443



External Views

External Views for the following models:

- MacBook Pro (13-inch, 2016, 2017, 2018, 2019, Four Thunderbolt 3 Ports)
- MacBook Pro (15-inch, 2016, 2017, 2018, 2019)

Port Views



A = Headphone Jack

B = Four Thunderbolt 3 Ports

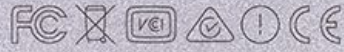
Bottom Case View

You can identify models by the model number on the bottom case.

Note: The image below shows the MacBook Pro (13-inch, 2016, Two Thunderbolt 3 Ports) model number location. The model number is in the same location for the products listed below.

- MacBook Pro (13-inch, 2016, Four Thunderbolt 3 Ports): **A1706**
- MacBook Pro (13-inch, 2017, Four Thunderbolt 3 Ports): **A1706**
- MacBook Pro (13-inch, 2018, Four Thunderbolt 3 Ports): **A1989**
- MacBook Pro (13-inch, 2019, Four Thunderbolt 3 Ports): **A1989**
- MacBook Pro (15-inch, 2016): **A1707**
- MacBook Pro (15-inch, 2017): **A1707**
- MacBook Pro (15-inch, 2018): **A1990**
- MacBook Pro (15-inch, 2019): **A1990**

Designed by Apple in California. Assembled in China. Model A1708 EMC 2978 Rated 20.3V= 3.0A max.
FCC ID: BCGA1708 and IC: 579C-A1708 CAN ICES-3 (B)/NMB-3(B) Serial

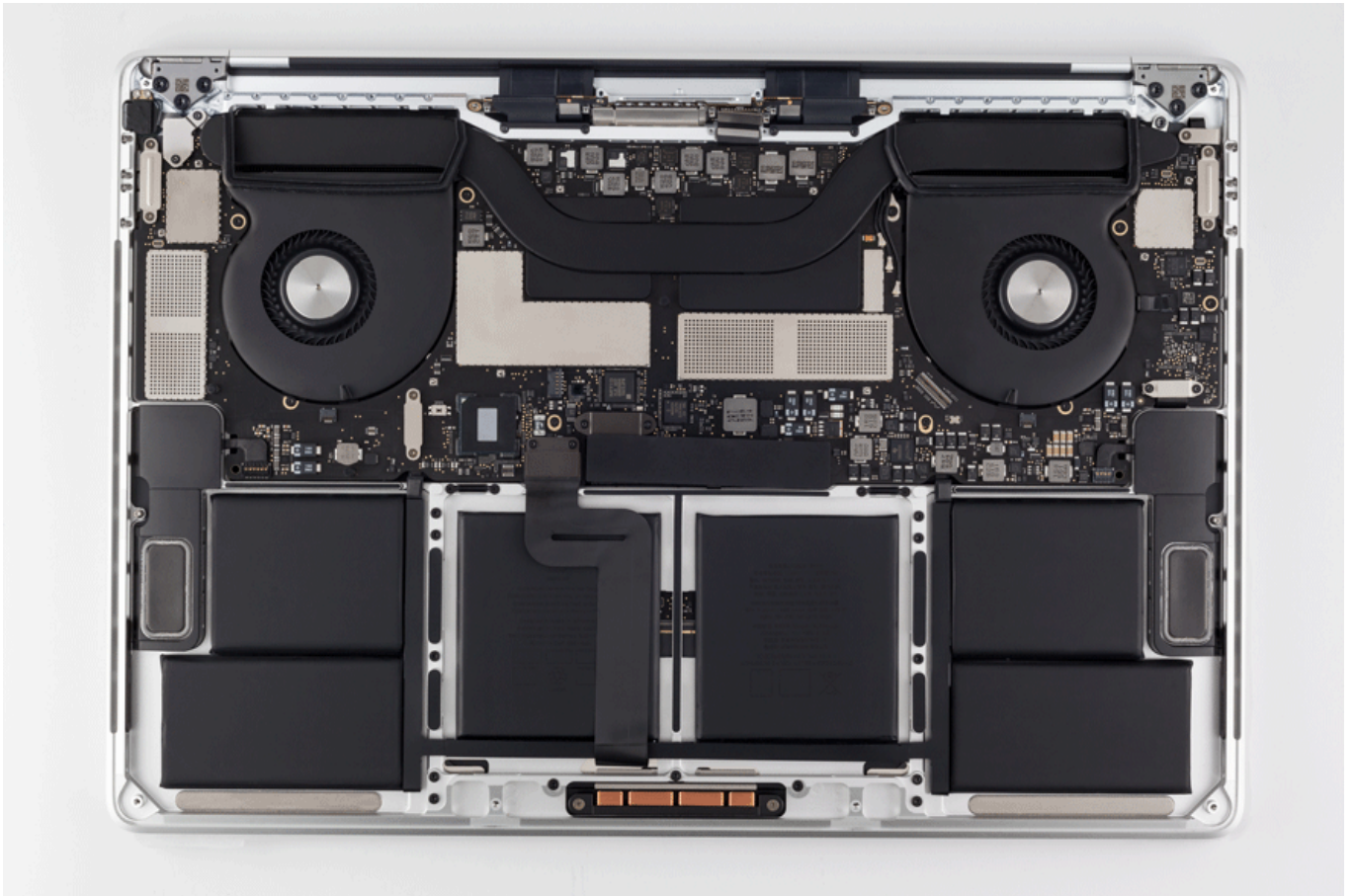


Designed by Apple in California. Assembled in China. Model A1708 EMC 2978 Rated 20.3V= 3.0A max.
FCC ID: BCGA1708 and IC: 579C-A1708 CAN ICES-3 (B)/NMB-3(B) Serial

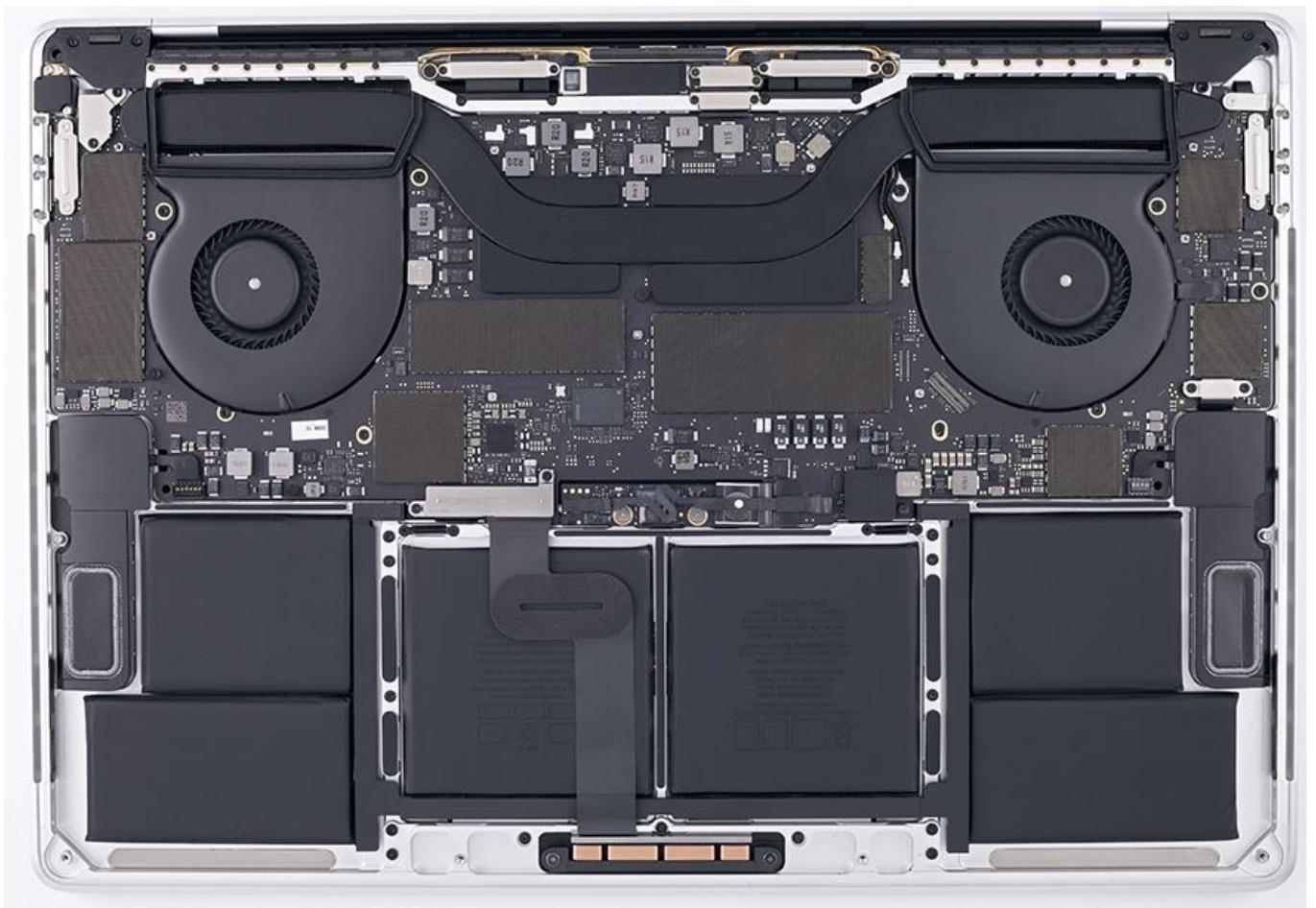


Internal Views

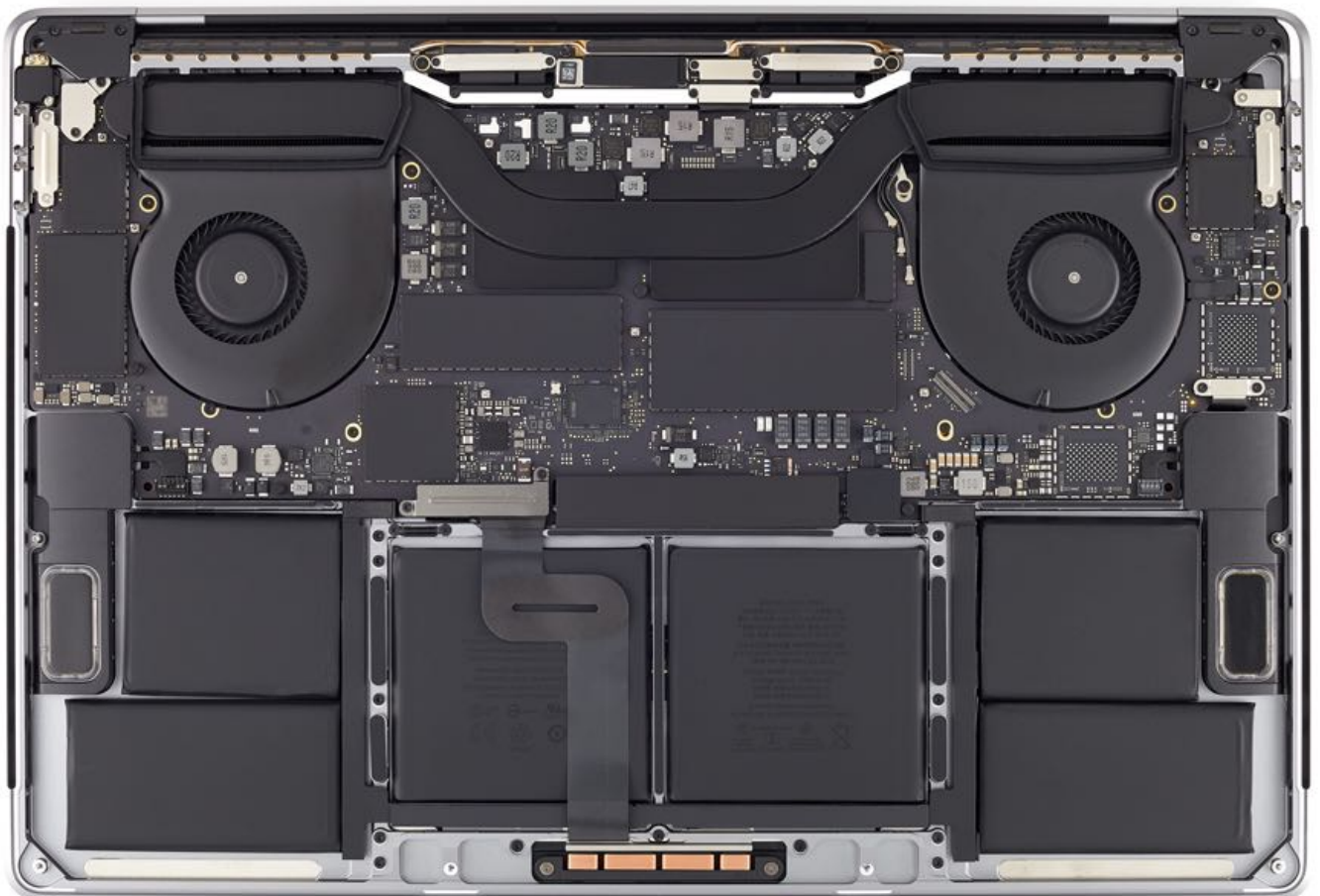
Internal view of MacBook Pro (15-inch, 2016 and 2017)



Internal view of MacBook Pro (15-inch, 2018)



Internal view of MacBook Pro (15-inch, 2019)



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